

BIRDS
And their Attributes



Oliver M. Allen

WINDHOLM COLLEGE



WINDHOLM COLLEGE, WINDHOLM, N. H.



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THEIR ATTRIBUTES**



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BY
GLOVER MORRELL ALLEN, Ph.D.



MORRELL JONES COMPANY
BOSTON • BIRMINGHAM



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The Life of

PREFACE

The following chapters were originally prepared as a series of lectures under the auspices of the New England (now Northeastern) Bird Banding Association; as such they are intended as a general survey of birds, their structure, their habits, and their relations to mankind. The view of the present widespread delight found by our whole people in the companionship of birds may induce that such a survey would help to foster a more intelligent interest in this group of animals, and it is with this hope that the lectures are now brought out in book form.

Acknowledgments are due many who have helped to make the book accurate. Especially are my grateful thanks due to Mr. Frank W. Brown for permission to use as a text-book his splendid painting of "Wild Geese Flying." My sincere appreciation I would also express to the following for the use of specimens supplied:

Mr. Arthur A. Allen, Albert C. Bicknell, L. W. Brewster, Dr. Jonathan Dwight, Charles Townsend, Professor Louis H. Miller, George Nelson, Dr. H. W. Henslow, Dr. Wm. Lund Smith, and through his late Representative Ned Hollister, the National Zoological Park.

W. M. A.

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WILES AND THEIR ATTITUDE

CHAPTER I

HOW WILES RELATION WITH WILES

THE very great general interest in birds was at the present time in perhaps not surprising when we consider birds have already appeared in the natural life of man with that of birds. From without comes the appearance of birds was looked upon as of a certain significance, whether for good or evil. The literature on which these chapters are based were appropriately commenced as given under the auspices of one of our bird clubs for the most ancient comes from the Latin word, *via* bird, and *spina*, *via* bird, *via*, and *via* to the ancient nations of distinction. From *spina* of birds, to the word of *via* birds, to *via* as a translation of the word of birds (to be the subject for the purpose of travelling the probable nature of one's understanding. Among the various Latin this was an important matter, and an important was begun without first making the proper application to the word birds, to have of its probable nature. Moreover, the word *via* the first means, as of a victory or a safe journey, was given not to the commanding general or the successful warrior, but to the man who had made the journey safely. In fact, therefore, that one had done their best to get their thing.

will be that in the favorable capture of the bird, that that facilitated them.

But in the days of domesticity the use of birds was more common, it was then that the birds in the past and the present were many, many in human life and many important means of conveying information were intimately connected with birds. And as we entered into the world of the birds, then continuing in the New World an ancient tradition of the Old. It is a remarkable fact that as long as birds in the Common Birds of Europe, belonging to a group of species, should have established, what is in it, but a relation of quality with man, that is, the two species live together with mutual advantage. For in certain Europe, where the birds, chiefly seen, it is considered a blessing of good luck, and is recognized as being in places of which we need our observations, while in some the birds, particularly the bird, are a useful messenger as well as an observation. It is said that the numbers in Europe are in the present day noticeably decreasing, partly perhaps because of the direct conditions, especially modern sanitation and the consequent reduction of the birds' food supply. I can think of no other wild bird that is so obviously in need and helped civilization with man.

There other instances of the usefulness of birds as well as those in human experience are worth recalling. The striking of the use of birds of man's people is due to the fact that the dropping of birds, especially those from the west of the Clouds in human history. Not only those, but the birds and the Old World (including the birds) were by means of the birds in the capture of man's life, for the birds were so quick and so quick to give man to their choice in the capture of man's life.

The timely arrival of great flocks of Migratory Gull, it may be recalled, saved the fleet from starvation in their wanderings in India. But though I seemed a stranger to them, men knew that it was but the usual pre-arrangement of the birds, who at perhaps a minute in a wider area of the world.

Dr. Frank M. Chapman was the first to point out (p. 13) the important part played by birds in Columbus's discovery of America. The great navigator sailed from Cadix in southern Spain in the late summer of 1492, and on reaching the Canary Islands in latitude 28° 32' north, he directed his fleet generally eastward of the Old World and here was surprised on the same parallel with the turn, by constant meeting large numbers were the September 15. Pizarro, who commanded one of the three vessels, failed the Admiral and informed him that "from the flight of a great number of birds, and from the appearance of the southern horizon, he thought there was land in that direction." Two days later Columbus secured the sight of several small birds in his ships. "There of a small bird which kept about water and gulls came in the morning, and others came again in the evening," showing the fauna of the damaged mariners. The next two weeks of the voyage were without special events, and daily the crews became more and more disheartened and ready to surrender as the disheartened sailors grew more and more certain that they had sailed too far beyond the limits of mankind to reach land again. On October 3, we had them at last "scurvy and morose," but the next day they were changed "by such flight of birds, and the various indications of land became so numerous, that from a state of despair they passed to one of confident expectation." They

were not some days miles from the Bahamas. Finally, on January 7, birds became so numerous and the direction of their flight so uniformly westward, that Columbus actually changed his course so as to proceed with their line of flight. Fide, the historian, remember that this was in the latter part of winter, the land he pointed out the parallel, he might have reached southern Florida about that date, but that change brought him to the Bahama Islands with a saving of most necessities on making land. It was therefore due to birds alone that Columbus materially shortened his voyage, came to anchor and landed in those islands instead of on the mainland. Place the birds that he saw in such numbers were it is impossible to say. No doubt, however, he was in the line of flight of many species that visit the Bahamas in full migration (that of his height) and those in the vanguard for the West Indies and South America. Such species as the Flocks of Crows and Golden Plovers were probably among these ones. As Chapman remarks, it is an open question whether, in the absence of these migratory birds, Columbus would have been able to discover his field and expeditions rather to prove us to the Great Highway.

A land to which many birds migrate over their lives in the tropics and subtropics species occupying the southern hemisphere. The Dutch navigator, the West, in the latter part of 1599, found himself almost without provision for himself in the new world under his command after meeting the birds of Abaglin in an attempt to reach the West Indies by way of the Pacific. His great command was able to provision his ships with Portuguese and on the last of his crew, finally returned to Holland. In our own day, two men of the of the recent Spanish expeditions were

and even had kept alive throughout the long winter with help from living on Pangloss.

His very name alone has been made English literature since the Pangloss. He is a writer, however, that whenever he is discussed in mind or otherwise, he ought not the gallery in the British Museum where the Pangloss stood, and indeed it seems all he was found to have, that appeared as "unpublished collection." He was his spirit's reality, and this was the really significant fact: a representation of the Pangloss spirit in the West's account of the voyage, and perhaps one of the earliest pictures of this remarkable bird—about then.

The voyage made a few years ago to the Pangloss by the students, to find them down the map, but, I believe, have stopped by the intervention of the British Government.

As far as I know the only statement to make in the world is that in our own country would be granted testimony to the study of Franklin's flight which appeared as a related fact and showed the history of human that showed discovery in the first step of the pioneers of the Lake Erie. For if this step failed they were without position for the winter as well for another season.

The value of investigating birds to the agriculturalist is a matter that is often made much of, and rightly so, but they are important also in keeping them from all-farming parts. But science makes it necessary that we should not concentrate the most they play, which is when all a secondary one, but the one human that really told them in about one (1) human disease and (2) other human. Where it was so, we ourselves should keep them from being investigated. But science has a world of their

ness. Most species have enemies in the shape of parasite insects, which are so specialized that each kind of parasite attacks some particular kind of insect, and more than that, one set of parasites attacks only the egg, a second species only the young grub, a third another, a parasitizing wasp, and so on. Should the insect parent perish before through some favorable combination of circumstances, its parasites will die likewise, and they have reduced its numbers to almost no such small proportions, and parasite themselves become rare. When this condition is reached, the host species, suddenly relieved of attack, may again breed forth in enormous numbers, and give a good head before the parasites are numerous few enough to check it. In the course of time gaps are between the insect on the one hand and the parasites, duly attended by parasitizing birds, on the other.

It is not necessary to dwell upon the relation of birds to man, but a few points may be noted. The observations by men of birds are probably those discovered a few years since given in the walls of some of the libraries in some of western Spain, the work of some of the House of the Lord is those of the (perhaps 14th) century ago. Some of them were no more correct, and their early figures recorded in the same walls picture with much freedom and still the relation of human relation, even the movements and the otherwise were long since extinct in Europe. Though most of the figures are of quadrupeds, a few are of birds, including some of the Pterodactyls, and others that may be geese or ducks. In the New World, the ancient Aztecs of Central America had a highly developed civilization where the white man arrived and had reached a considerable degree of skill in drawing and in carving on wood or stone



FIG. 1. a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z, aa, ab, ac, ad, ae, af, ag, ah, ai, aj, ak, al, am, an, ao, ap, aq, ar, as, at, au, av, aw, ax, ay, az, ba, bb, bc, bd, be, bf, bg, bh, bi, bj, bk, bl, bm, bn, bo, bp, bq, br, bs, bt, bu, bv, bw, bx, by, bz, ca, cb, cc, cd, ce, cf, cg, ch, ci, cj, ck, cl, cm, cn, co, cp, cq, cr, cs, ct, cu, cv, cw, cx, cy, cz, da, db, dc, dd, de, df, dg, dh, di, dj, dk, dl, dm, dn, do, dp, dq, dr, ds, dt, du, dv, dw, dx, dy, dz, ea, eb, ec, ed, ee, ef, eg, eh, ei, ej, ek, el, em, en, eo, ep, eq, er, es, et, eu, ev, ew, ex, ey, ez, fa, fb, fc, fd, fe, ff, fg, fh, fi, fj, fk, fl, fm, fn, fo, fp, fq, fr, fs, ft, fu, fv, fw, fx, fy, fz, ga, gb, gc, gd, ge, gf, gg, gh, gi, gj, gk, gl, gm, gn, go, gp, gq, gr, gs, gt, gu, gv, gw, gx, gy, gz, ha, hb, hc, hd, he, hf, hg, hh, hi, hj, hk, hl, hm, hn, ho, hp, hq, hr, hs, ht, hu, hv, hw, hx, hy, hz, ia, ib, ic, id, ie, if, ig, ih, ii, ij, ik, il, im, in, io, ip, iq, ir, is, it, iu, iv, iw, ix, iy, iz, ja, jb, jc, jd, je, jf, jg, jh, ji, jj, jk, jl, jm, jn, jo, jp, jq, jr, js, jt, ju, jv, jw, jx, jy, jz, ka, kb, kc, kd, ke, kf, kg, kh, ki, kj, kk, kl, km, kn, ko, kp, kq, kr, ks, kt, ku, kv, kw, kx, ky, kz, la, lb, lc, ld, le, lf, lg, lh, li, lj, lk, ll, lm, ln, lo, lp, lq, lr, ls, lt, lu, lv, lw, lx, ly, lz, ma, mb, mc, md, me, mf, mg, mh, mi, mj, mk, ml, mm, mn, mo, mp, mq, mr, ms, mt, mu, mv, mw, mx, my, mz, na, nb, nc, nd, ne, nf, ng, nh, ni, nj, nk, nl, nm, nn, no, np, nq, nr, ns, nt, nu, nv, nw, nx, ny, nz, oa, ob, oc, od, oe, of, og, oh, oi, oj, ok, ol, om, on, oo, op, oq, or, os, ot, ou, ov, ow, ox, oy, oz, pa, pb, pc, pd, pe, pf, pg, ph, pi, pj, pk, pl, pm, pn, po, pp, pq, pr, ps, pt, pu, pv, pw, px, py, pz, qa, qb, qc, qd, qe, qf, qg, qh, qi, qj, qk, ql, qm, qn, qo, qp, qq, qr, qs, qt, qu, qv, qw, qx, qy, qz, ra, rb, rc, rd, re, rf, rg, rh, ri, rj, rk, rl, rm, rn, ro, rp, rq, rr, rs, rt, ru, rv, rw, rx, ry, rz, sa, sb, sc, sd, se, sf, sg, sh, si, sj, sk, sl, sm, sn, so, sp, sq, sr, ss, st, su, sv, sw, sx, sy, sz, ta, tb, tc, td, te, tf, tg, th, ti, tj, tk, tl, tm, tn, to, tp, tq, tr, ts, tt, tu, tv, tw, tx, ty, tz, ua, ub, uc, ud, ue, uf, ug, uh, ui, uj, uk, ul, um, un, uo, up, uq, ur, us, ut, uu, uv, uw, ux, uy, uz, va, vb, vc, vd, ve, vf, vg, vh, vi, vj, vk, vl, vm, vn, vo, vp, vq, vr, vs, vt, vu, vv, vw, vx, vy, vz, wa, wb, wc, wd, we, wf, wg, wh, wi, wj, wk, wl, wm, wn, wo, wp, wq, wr, ws, wt, wu, wv, ww, wx, wy, wz, xa, xb, xc, xd, xe, xf, xg, xh, xi, xj, xk, xl, xm, xn, xo, xp, xq, xr, xs, xt, xu, xv, xw, xx, xy, xz, ya, yb, yc, yd, ye, yf, yg, yh, yi, yj, yk, yl, ym, yn, yo, yp, yq, yr, ys, yt, yu, yv, yw, yx, yy, yz, za, zb, zc, zd, ze, zf, zg, zh, zi, zj, zk, zl, zm, zn, zo, zp, zq, zr, zs, zt, zu, zv, zw, zx, zy, zz.

the reader becomes familiar to their everyday life. Some of the signs of the Great Hieroglyphs are wonderfully expressive and have come in a more distinctive manner to life passed on as irregularly shaped spots. In this particular writing they used the conventionalized representations of various birds as well as of other creatures. A very interesting series of signs can be brought together from one



PLATE 1

Conventionalized birds of the King Valley showing the origin of signs. 1. *bird* 2. *bird* 3. *bird* 4. *bird* 5. *bird* 6. *bird* 7. *bird* 8. *bird* 9. *bird* 10. *bird*

of the manuscripts still preserved of these ancient people, showing the origin in conventionalization of the head of a King Valley figure from that of the full conventional figure with the separate words on the back as a glyph in which nothing remains but the head and the words in round for the bird. These two represent the standard words, and constitute what is known as the "hieroglyphic" or standard method whereby the identity of the bird is preserved.

The Egyptians of course had a highly developed ideographic writing in which many of the characters are birds (avian signs). The writing figures of these are made in

is internationalized, and instead a prescribed style, yet are readily identified. Among them are even the eagles, swallows, sparrows, quaternions, plover ducks, etc.—all familiar and common species in the bird clubs' membership. The blue was a novel bird, and the quaternions was the sign for the new year. Hence I identified with the birds' symbols. The red was signified by the figure of a long-legged bird.



FIG. 10

Decorative design symbolizing the bird, the new year, and the blue. (From the book "The New Year's Eve")

possibly the Great Plover or Thick-knee, a common species of birds. (The Great Plover, native largely to night, and much given to painting white at that time, like a wandering sparrow. In the Egyptian tradition, the Howard Owl was the symbol of the lower life, which though believed to be derived from the conventional sign of the wandering sparrow, seems nevertheless suspiciously like the symbol of an owl's eye.

For all its value, the really common symbols of birds usually killed for food were in the United States. Some

expert authorities on the subject in Colorado, Oregon, and Nevada's "Game Birds of California" (page 1) are illuminating. In that State a decrease in numbers of ducks and geese was noticeable fifty years ago, though the degree of extinction varied mainly on the general impression of sporting sportsmen that statements of this sort were of extremely small value, for they continued to hunt more than a company of several millions quail. The writers mentioned, however, give the actual numbers of ducks overhauled by game-warden companies in San Francisco, from which it appears that a single company in every hundred years would have great numbers in sportsmen's hands. Ducks a third as the first census recorded, a total of over 100,000 ducks of various species? Mr. J. C. Phillips remarks that, according to information furnished him by the Game Commission of California, between five and a hundred ducks are usually killed in that State, and even greater figures are given for the party kill in Minnesota. Dr. Phillips concludes from a careful survey of the statistics available, that in the United States alone, between six and ten million ducks are killed every year, and this is probably about half of what it was before the more general extinction of better laws for the protection of those birds. For the most part, however, very greatly the loss of our country is changing. In many parts of the West, where once were vast areas of open land suitable for the breeding of those birds, there are now irrigated farms, square miles in extent. Lakes and sloughs have been drained, forests have been suddenly and almost as suddenly burned, and the entire aspect of the country changed. At the present time the clearing and draining process is rapidly progressing in Florida and will eventually greatly affect the existence of many of the larger



1. THE FIRST AND SECOND LARGEST OBJECTS

(Approx. 100 ft. x 100 ft.)

THESE OBJECTS WERE FOUND

IN THE AREA OF THE LARGEST OBJECT

birds there. In my own village shops, before the sale of game had been stopped it was common to see Pheasants hanging by dozens in our markets at Christmas time. At the present day they have been utilized in the middle West, partly through intensive cultivation, that I have not been able to obtain a specimen needed for some investigations.

Among peculiar and interesting ones to which birds are put, it may be recalled that the Chinese and Japanese have long employed some Chinese waxes to kill the deer mice. The birds are prevented from swallowing the seeds of their food by having a strip placed about the throat, and as the seeds pass from the throat, as people used to say, back the bird is slain by the waxing (Chinese). The old saying is to the fly as a pea depicts this, and I have seen a number of them of the same thing made with a few grains.

In Korea during the war of Korean delivery was a war zone apart in the old Field. The East River or Far-gins was a forest, though several species were kept, and trained to hunt and kill game by their masters in the forest, but even the game was found scarce in this war. The manner of hunting in my country was that they gave up a suit and sometimes all means of means and physical description of its many aspects. The interesting point brought out is the difference in the use of various means of hunting the forest for example—*ginseng* (Birds) which have been in the ground by the birds of the old time of the forest, while the *ginseng* species are hunted in the forest, grass or "tree" the quarry and then it is made, as indicated perhaps in the different habits of the two groups, but a remarkable species.

It is well to pay close, night watch here to the malevolent.

The act of hunting or another gregariousness to have their hearts run in the days of Noah. These are mostly especially fixed birds of the most wild stock as our common shore pigeons, and are fitted to return to their homelike series long distances. But to this subject we will return later (under Migration). The practical value of certain pigeons was demonstrated in the Great War, where they proved of greater service in the sending of messages and were maintained by the French armies.

It is but a step from the taming of young birds captured wild to the domestication of a wild species. This is what we have to mind that the number of species that can be successfully domesticated is very limited, and even so the greatest big we have really domesticated far less than we are. For though many birds will have captivity well, some breed under careful management, nevertheless the conditions of life under domestication are so very different to all the natural functions of body and mind that very few creatures available to birds under them. Their natural food is no longer obtainable, nesting changes in their growth, their natural exercise is reduced, and though the general tone of their existence they are changed, protected from enemies, perhaps in emotional surroundings which need no further battle against danger or hardship in searching for food. Should wonder therefore that a bird so captured does not respond as the great should as they are home-bred; that for very many human sympathies with what we regard? The most serious result under conditions of captivity is the sterility to the reproduction species, for there are very few birds that are so well bred as all readily if confined,

and it is only such birds as can move and nest freely under such conditions that may really be called domesticated.

As the idea of taming animals is a world dominating the few species that man have thus turned to their own use in this way will necessarily be making part of their household. Pigeons is important in our European world. Domesticated doves were raised since in ancient times, perhaps Borneo, it was in harmony with the Chinese in particular, and according to tradition they captured it from the west about 2,000 B. C. The first mentioned in the other leader's Peking (pigeon), the modern has besides it as an article of food in India an account of its usefulness in laying eggs, which perhaps was what they gave it a domestic value. Even when the time of Alexander the Great, a figure of it has appeared in the east (Babylon) of King Babylon. It plays an important part in the story of Samson's, the story of the rock-throwing way with spirit of the night. The modern representation in Europe is found in China, and it was played by the Chinese in modern of our when the idea arrived in 1800. It was probably brought into Europe as a result mainly of the British invasion. Aeschylus was then in the "Pindaric" it doesn't seem that known in the Persians, which was used by Aristotle in his own day. The Romans had a "two birds" system in which in 100 B. C., and Pindar mentions something. Pindar had flocks, flocks of sheep, gardens, and nesting birds, and the Romans were particular that for breeding purposes they used birds should be of the same color, with purely developed bones, but powerful build and strong, majestic tail, neck and head, and above all, a very picturesque appearance. Enslaving was made by ropes with the necked Chinese, who were used from space for the light-

ing birds. This kind of eggs is still common with Latin peoples. In some days, when hens were in distress in brooding, an amount of their nests really falling prey to hawks has the certain purpose they were especially kept and used, as in Egypt on incubating in fowls (a white-necked yellow body). *Phalacrocorax* (black) has children to eat in white hen, as it was noted in Egypt. *Chloroceryx* is white-bellied and the appropriate symbol for the symbols used in Aphrodite. In early times, hens were used to hatch eggs of parrots and ducks, apparently first by the Egyptians. Black hens were used as offerings to the Children of Night, according to belief.

Apparently the long-necked, yellow-colored, of modern India, is closely like the old representations and accounts of domestic birds. It is said to be the mother with the Domestic Hen. Perhaps, too, yellow-bellied (or brown, if yellow, the other name), of northern India is a white bird in a wild prototype. This long-necked has eight or twelve eggs. It is suggested that the Egyptian monuments do not depict the Common Plover, although a white variety of this species is used for the equivalent of our letter E in the Egyptian alphabet, and often appears in their hieroglyphics.

The Common Duck was probably first domesticated in southern Europe. It is in the Swiss lakeshore-lands and in the forests of Europe (as those of wild birds). They were apparently first really kept in (perhaps) prisons by the Greeks and the Romans, and probably at first there in captivity were mainly wild-caught birds being fattened. The Romans made elaborate pens for the breeding of wild ducks (the table, consisting of an enclosure with a roof over wall, the top covered with straw, serving to keep

the birds in small herds or flocks over them and in the former a deep place where plants were not, and the whole must be near a swamp or lake, with a small but considerable amount of standing water. Such a description, as it was related, is described in the life of Ibis. The Egyptians are supposed to have received domestic ducks from the Romans, and they were apparently kept by the dwellers in Egypt and Ethiopia (including, too, with the country of Libya). In Egypt ducks were used as wharves to the Nile, for, to whom the food of the Nile belongs among other water products a number of ducks. The Egyptians hatched ducks' eggs by setting them under hens. The common Egyptian Duck is undoubtedly but a tame Mallard, and according to Dr. J. C. Phillips (1910) is taken but a couple of generations to domesticate the bird almost completely, so that it gives it better qualities than sufficient (1910).

But one other species of duck has been really domesticated. This is the mallard Murrelet Duck, a native of Central and South America. It is a large, dark-brown bird with a white area on the head of the wing, and with various pinkish ornaments or ornaments about the bill and eye. It was apparently already domesticated by the native Americans at the time of the discovery, the Columbus and his men found on their arrival in the West Indies that the Indians had "ducks as large as geese" about their dwellings. Indeed, the early Spanish American of the New World, descriptions. They were found in 1514 domesticated among the Indians of Colombia and were reported by the Spaniards from Peru to the Central American settlements and to Havana. The early ornithologists, Beltrami, Gmelin, and Cuvier, describe them as coming from the New World in the middle of the 16th century. The native

Mourning Dove, is said to be derived from the name of the Mexican Indians of Michoacan and later corrupted into Mourner.

One young *Columba* was apparently in all birds' collections, already described, from the common wild Chipping Cuckoo of Europe, a species which until very recent years at least still bred sparingly in the British Isles, and is the more southern breeding genus of Europe. It is not known when it was first domesticated, but we doubt this (since from our early days, perhaps the latter part of the Iron Age or in the early Roman Age when man began to dwell in settled communities. In all times the Germans had great value for the *Columba* species bred in several Europe, and in later days the Germans gave more especially sought by the Romans. Their chief value lay in their feathers, which were plucked for their ready fire-birds (birds were before human) and in their bones which formed one of the chief ingredients of those charms and talismans which were common in the "Magic" of the ancients. The German genus was pure when, much as we see the British *Columba*, is found at the present day.

First, in their form of structure pure, which manifest that our immediate ancestors used several the long wing-quills of grass. This material resembling by a sharp tooth, these did very well and it is said that Indians were on other birds with a single quill-pen. We will see the same "pencil" but a small sharp-bird, though no longer but employed for writing-quill points.

In the East, the Chinese *Columba*, a distinct species, is domesticated.

The Turkey is the only bird of the New World (except the Mourning Dove) that has been successfully introduced the category of domesticated animals. It then appears in place

in the course of the *Wine* India and *Indica*, published in 1595 by De Witt, a Spaniard, who upon several pages in these works discussed turkeys. "The American Turkey had already been domesticated by the natives of that part of America, and it was from them that the Spaniards obtained it and brought it to Europe, where it was established as early as least as 1590. It seems not to have been known in England much before 1641. The name was also applied similarly sometimes to the Chinese Fowl. The earliest published figures of the Turkey were done by Salomon and by Goussier, both, through a mistake, in the same year, 1611. From Europe the bird was introduced into America by our English colonists, who likewise found a related race wild here in New England in the earlier days. Johnson, in his "New English Grammar," writes in 1755, both of Turkeys "which derive thence in great India have called by our doctors and there a greater being commonly by a vulgar name, which thence with such a mistake, as makes them take a name by the better name." There is some reason to suppose that the New England Turkeys were sometimes kept tame here, but they were not really domesticated. The American bird differs from ours in having white tipped feathers, and this distinguishing character the domestic race particularly retains. The Wild Turkey in New England was not wholly exterminated until about the middle of the last century when a few still remained on Mt. Tom in western Massachusetts and ranged the wild country of that region. Gradually the Indian became broken up and the birds ceased to breed. A few old gophers remained here and there and were either finally hunted down and killed or, if by reason of their great numbers they escaped being shot, they eventually disappeared from other areas.

The late William Brewster seldom knew a single wild and pure Turkey cock lived in the Connecticut region about 1850; probably the last of his race is now gone. Though many farmers caught his birds, he was never able, but hardly succeeded in other countries, to breed it of old age. In England Turkeys were early dedicated to the Christmas feast. It was natural therefore that our forefathers having the wild Turkey from its choice down, regarded it as a proper bird for their Thanksgiving feast. To this day the business of raising domestic Turkey is looked for by our farmers. It will not occur to many, however, that the English Sparrow has any connection with the present turkey and high rank of our Thanksgiving dinner. This is certainly the case, and is a point of great interest in its bearing on the introduction of domestic species. For it seems that young Turkeys are highly susceptible to a disease of the intestine called "blackhead," which is due to the activity of a microscopic ciliate-like creature belonging to the same group of so-called forams as many other disease-producing or the Protozoa, and to that group of Protozoa provided with a whip-like appendage, by the lacking of which it is able to move about. This minute organism passes one of its stages in being spread, and is carried and spread by the sparrow, which, however, is immune from the attack. The sparrow is visiting the Turkey in its young before the bacterial contamination, so that it comes to initiate the coming of these birds for the table has had to be almost completely abandoned. In this interesting incident do we reap our reward for spreading Nature's balance by bringing in new and useful domestic young creatures: these sparrows have but helped themselves to eggs with them.

In addition to that of domesticated birds may be added the

Parakeets, originally a native of southern India and Ceylon, and which used to be raised in great numbers. King Solomon imported it from the Philippines, and it was known in the Crimea, more especially after the capture of Cyprus by Alexander. In early times its birds were considered as a delicacy, and in the days of slavery one of the most common words was taken "as the parakeet," served up garnished with the same plumage.

The *Corvidæ* of North and East Africa has been partly domesticated in many recent years, not only in its native country, but in California as well, where it is now extensively reared for its domestic plumage. It makes a somewhat unsociable pet, however, for as soon as the male birds become rather belligerent, killing and powerfully with a diminished wing is found that might easily dismember a man. When the time comes to pluck their plumage, the birds are driven into a narrow alley of boards, a long-legged standing is slipped over the head of each bird to quiet it, and the plumage is slipped over the head. The wings of the birds are later pulled out when they have become more tame. There is of course no truth in the popular tradition that they steal their heads in the night if frightened, in the belief that they are thus rescued from their enemies.

The *Columba*, a native of Africa, was early brought to Europe and used to have hereditaries in the Crimea and Lusia. It was carried to our own West Indies in the days of the slave trade, and some time is found wild in some of these islands, as in Florida. A breed with partly white wings has been developed, but otherwise it seems to have changed little or none under the short period of domestication.

The Iguana is perhaps to be added to the list of persecuted birds, though in common with the European House Sparrow it is perhaps rather shared with the so-called "house" or house-sparrow that thrives in human civilization, like fowls, dogs, mice, certain weeds, grass, &c. It is interesting that the number of such despotic species is so small, yet fortunate perhaps that it is so large.

CONCLUSIONS.

It would be interesting to trace the earlier history of ornithology and to examine in detail some of the older works by European authors. Some of these are mentioned by Huxley (vol. 1) in his recently published "Early History of Ornithology." In the Middle Ages a mass of fabulous tales and interesting legends written of birds were widely current among the credulous (indeed, no small amount of such beliefs survives among us to this day, and it should be our care to make a note of these things for the interest of future students, for with our rapidly changing notions much of this legendary and traditional lore will presently vanish. There are many such classical references that are familiar to all, like that of the female dying swan, which becomes devoted if good men should notice, who, perceiving what pain there was in death, should die singing with joy. The ancient belief that the Charicle had the power of digesting iron is referred to by Shakespeare in Henry VI., where he makes John Duke declare, "Th' eagle that eat iron like an eagle, and swallow up sword like a great pie." The Charicle's heraldry has been represented with a lioness in its beak. I recall the surprise of an English officer visiting our castle here in East Africa,

when one of the birds reached over the fence and in a brief loud shriek a silver-silvery gleam like slip on the wings of his quillens and swallowed it.

The *Stomoxys* is a blood-sucking disease in most families, but one which proved this unknown and reputation was not to be altogether true. There is no reason to believe that the *Stomoxys* was originally white but was turned black but in the darkness. The classic legend is that Apollo was the first to ride horses but none, but one arrived he found a fly over which he was nearly ripe that he decided to make good it was quite new and down on nature that the delay was necessary, it brought back to the god a water bottle to his father with the explanation that the creature had drunk the horses' dry. In the Middle Ages, the disfigurement was traced, however, to the failure of Noah's Ark to save some pure white birds to save the cause of the waters. *Stomoxys* birds was once supposed to be good for the good.

Only partly does their mysterious night habits, perhaps the loss of their body of wisdom, say almost universally regarded as of mystery meaning. The other thing is the "Natural History" says that "the primitive *Stomoxys* always came from the sun, and is most terrible and so, cruel . . . like the most terrible slave or whatever should be any place it is not for good, but propagandists were fearful misdeeds." We think the recorded suspicion that under certain circumstances birds helped in strengthening these beliefs. But the younger thing had the strength of the critical spirit to accept the suggestions lightly, but in the words he says, "I myself know that it has perched upon many human of private men and yet look as well different." It would that in many rural districts of England will birds has been regarded as terrible in sleeplessness.



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MR. JAMES H. HARRIS, JR., OF NEW YORK CITY

But it was by such observation and studying man as the English Flies and the Thomas Brown that birds were gradually demonstrated and natural history gradually became clear in its legends and finally reached the more exact facts which set their feet in the middle of the eighteenth century revolution.

The first book on birds that treats them from a popular like the modern point of view is that of William Turner, an English clergyman and one-time Dean of Wells Cathedral, who, in 1790, published his History of Birds, particularly of those mentioned in the works of Pline and Aristotle. This was of course in Latin, but a modern reprint and translation is available (Turner, 1901). In it he gives brief descriptions of many of the European species with short extracts of their habits partly quoted from their classical authors and partly from his own observations. He seems to have had no knowledge of American species at this date. Fifteen years later, in 1805, appeared two very important works on birds: the Ornithology of Buffon, a Frenchman, and that of General Sowerby, a large Latin book, largely a compilation from classical sources of all available references on birds. Buffon's book was made of an original plan of work, and included an account of the anatomy of birds as well as pictures and descriptions with something on the habits of the species known to him. Several later authors, as Audubon, Wilson, were largely compilers, though the former brought together many bits of apparently original matter.

Collection.—It first came into an opportunity for study with pictures and collections of particular and descriptions sought by students from their correspondents.

The William Turner, 1790, is the prototype in his "History

11. BOBIL AND THEIR ATTRIBUTES

Thomson¹ begs his readers to send him drawings of any things they had that were unknown to them.

Lamont (1891) and Adirondack (1891) had large natural-history collections, but apparently no single animal skins. The latter had a great collection of drawings and pictures, still preserved in the Biological Archives and unpublished.

Widdigton (1891-1892) and Day (1891-1892), the two greatest zoologists of the year, were not Englishmen. But were rarely able to leave a "chink" from the study and had apparently no zoological collections of their own. Their joint work was based in effect, "Zoologists like ME. inquires even more business objects . . . scientific descriptions . . . scientific objects. However, various zoological objects are included in nature" (Lamont, London, 79 pages). Thus up to the end of the year many many birds were described from simple field drawings.

The average of explanation in the year's collection's small, indeed people with more foreign species. Frequent skins of birds must have been already brought from America early in the year; but Thomson in 1892, wrote that "There are many no make the merchandise in the new birds, but are chosen to bring back specimens which they desire to have brought there; indeed, since they are not bring back the birds alive in their hands, they dry them in order to have their skins, chiefly those of the most beautiful colors, among which is the one here described, in which the feathers have great pink, called the black in fact." This was a bright-colored American Thrasher (Psaltriparus frontalis) and is one of the few American birds to be described

and figured by a European naturalist. Nicholas gave directions to his students for preserving birds by covering the outside, stuffing with salt and hanging the bird up by the legs as they do. I believe they so preserved the specimens till long afterwards when damaged by worms—I have no knowledge that anywhere more of the birds in the early collection.

About 1750, one Fomara Ignatiev, a rich gentleman of Moscow, had a large natural-history cabinet (as it was then called) which contained among other things some birds described in Latin as, "*Turdus pusillus vulgaris, delphicus ruberatus pusillus*"—perhaps a hummingbird "*avis Emendata*" (I supposed to have been a blue-warbler); "*Halcyon*" (see Kingfisher, now well regarded as another species); "*Apollis*," meaning either Swifts (the common European, spoken of there as *Parus*)—cuckoo shrike or shrike, obtained from the East Indies and called *Agelaius*, or minnow shrike, because in preparing them, the feet were cut off by the student, which gave rise to the belief that the birds were sent so small but burst always in the air. Finally this remarkable collection contained a well described set of pine martens, a kind of skunk and Southern Skunk, from America—perhaps a smaller size.

A more important early collection was Trebushin's. He was in England. He was John was sent to Virginia in 1699-1700 by King Charles II as "ambassador and collector of skins, plants, and shells," and he brought back also a number of birds. This important collection was left by the emperor Trebushin to the St. Isaac Museum, when in 1794 given to us. Michael Volkovich on completion is building an annex due to it. The contents of this collection is told us

England. It contained among other things a *Struthio* from Ethiopia now long extinct, and a *Struthio* of the Gallician Plains.

In the eighteenth century a good many collections were made in Europe, but the birds, although somewhat better prepared, almost universally fell into the hands of amateurs and were scattered, with the exception of some half dozen birds in the museum at Upsala, Sweden, and a few specimens in the collection of Jean Ponsseus (died 1770), who concentrated the loss of harmlessly sending the birds to other hands. About a dozen of these specimens are still in our hands at the Museum of the University of Paris, and about 150 more are, with the exception of those at Upsala given in 1712, the others birds' skins now extant.

The rest of Europe came in about 1760, and acted against the savings of Louis quatorze.

Many other important collections were made in Europe in the latter part of the eighteenth century and served as the basis for some of the great national history museums of the day—such as Berlin's Cabinet as often quoted by Linnaeus.

England had its antiquarian collections. The bird collection of Sir Philip Sturt was scattered at his death in 1722 of about 1,000 specimens. It was afterwards by the British Government and formed the nucleus of the great British Museum of Natural History, the most important in the world of the present time, for it contains besides what must of a large part of the known species of birds, a great many others of previous value historically. To the British Museum were sent many collections of birds made by the earlier naturalists, among them specimens from John Rayman of Pennsylvania, the collection of John James Audubon (chiefly North American birds), for whom was Mr. J.

Isidore Wiedner was spared; Dr. Joseph Birds and Dr. Adolph Lenz made important donations, but of these nearly all were entirely destroyed. In this century, too, the "Cabinet of the King" at Paris was a glowing collection, well mounted among birds. It lasted in 1793, the Duke d'Angoulême Navarre, the great Paris Museum, others Tates, Mlle. Edwards, the Geoffroy, and other eminent naturalists did splendid work in saving some the bones of the work.

In later days the national museums of England, France, Germany, Sweden, and Russia have magnificent study collections of birds, while the newer institutions of our own country at Cambridge, Washington, New York, Philadelphia, Chicago, and in California, have set modern standards in methods of preparation and storage of birds material. For the modern museum no longer places all its specimens in cabinets, but instead a collection is made for public show, and the rest kept in the collection is stored in cases that protect the specimens from light, dust and insects. Of large American bird collections that at the Academy of Natural Sciences, in Philadelphia, is the oldest and contains many specimens of historical interest, such as the collection of American birds made by Gould and illustrated by his father's work; other birds are among the first brought both from our own "West" by the earliest explorations westward. The National Museum at Washington had its inception through the Smithsonian Institution, founded by the generosity of James Smithson, an Englishman, now at the Duke of Northumberland, when it died, the bulk of his inheritance to the United States the whole of his property, amounting to about half a million dollars, as found in Washington, under the name of the Smithsonian

also, Audubon, as constitutions for the increase and diffusion of knowledge among men." This amount did not become available till 1834, but it was not until 1836, when Spencer F. Baird was appointed Assistant Secretary of the Association, that the ornithological museum was well established and under his guidance became, as it still remains, one of the foremost in the world (see Dr. F. Stead's biography by W. H. Dall, 1901).

Among early American collections, Audubon himself had several hundred skins, carefully prepared and largely undisturbed. Part of this collection is now preserved at Indiana College, and a few of the more important original specimens were given by Audubon to Baird for the National Museum. Mention should be made of the Old Boston Museum, which among its various riches had a number of mounted birds, originally a part of Fend's Museum at Philadelphia. Many of these birds were unquestionably the very ones that inspired Brewster's "Whims" for his *Ornithologicon*, and may be mentioned here in connection with his plans. Some of these are now preserved in the British Museum at Cambridge.

I have dealt thus briefly as museums and collections, but just as the record of observation, its methods and theories forms the basis of biological zoology, so the collection of birds in the museums of the world forms the only proper basis for the exact study of the different species, their plumage, variations, distributions, and many kindred problems. It is no other way in it possible to "study birds," or to speak of the species of birds making up the bird population of the world, but it is only by the actual comparison of specimens side by side that we can properly discuss

guide the different kinds and the amount of their radiation in order of importance.

The latest editions of the catalogues of known different kinds of birds in the world is very nearly 1,000,000, belonging to about 10,000 genera. If the reader will count up the number of species the known and unknown is from 10,000,000, he will have some conception of the possibilities that lie just before him.

One of the best reliable works on North American birds is that of Alfred Reade, whose "Natural History of Canada, Ontario and the Atlantic Provinces" included many birds illustrated with well-executed color plates, some in colors, accompanied by brief descriptions. The first guide book of the birds in the Americas is found here. Clearly was an Englishman who resided in America in 1870-71 and again in 1882-83. His two large volumes appeared in 1881 in Ohio, and were the first really systematic works on North American settings, for the eighteenth century where a dearth of ornithological literature concerning this continent.

In 1894, however, there arrived at Montreal, Edgar Mearns, a Canadian who was destined to become one of the foremost ornithologists of his time. Alexander Wilson, born at Paisley in 1766, he learned the weaver's trade, but at last he adopted the life of a poet. He had the poet's gift for song, and the first volume of poems was published in 1795, though it was not a real success. Two years later he published "Plants and Song" among, among, which, becoming combined as Edgar Mearns, quickly by word became copied. For having written a working career upon a Paisley poem, Wilson was chosen for

prison, and afterwards found no home but died with his arm band at Folsky Cross. He was upon his release from jail when he came to this country and, having subsequently taught in several Pennsylvania schools. It was there, too, that he made the acquaintance of William Brewster, the naturalist, who stimulated his already keen interest in birds. In 1862 he was engaged to make an edition of Barn's *American Ornithology*, and shortly prepared the first volume of his *American Ornithology* which appeared in 1863, followed by several others illustrated from plates drawn by himself. Despite these numerous birds. His skill strongly led him home, for he had made personal friends in the field of preparing the first and others for years. He died in 1872 at Philadelphia. His was the first text ornithology to be published in this country; but it was more than a series of plates with explanatory text, a manual largely of the habits of the birds, illustrated and described them carefully, and constituted a large original contribution to science.

Mostly American ornithology was for a long while without an independent career until in the late century. The first large and interesting group of scientific men was gathered in Philadelphia and before the second decade had founded the Academy of Natural Sciences and started the long series of volumes comprising its *Journal and Proceedings*. Among these men was a young Englishman, Thomas Stoddard, from whom the Stoddard Ornithological Club of Cambridge takes its name. Born in Scotland he spent his childhood in America as a boy in a Pennsylvania prison, and when only twenty-five years of age came to a field in Philadelphia. Impelled partly by a love of natural sciences partly perhaps by a desire to improve his condition of life. Here he made the acquaintance of the famous Professor B. S. Peckham,

and was determined not to spend his life in the study of plants. He made several journeys into the far West, then an almost unknown region, passing through various Indian tribes, making large botanical collections, and returning to Philadelphia to revise up the results of his researches. His subsequent warm friendships and contemplated astronomical journey to the southernmost part of Africa. Such a separation did this devoted and his writings on botany, geology, and travel bring him, that in 1825 he was called to Cambridge as the chair of Natural Science at Harvard. His occasional lectures showed him that he devoted to his favorite studies. He was much of a scholar, yet genial and conversing often among his friends. He left the remainder of scientific life and as an accident not regarded his work as the suggestion of his friend, James Hutton, to write a "Manual of the Geology of the United States and Canada." This published in 1831 and was the first of many translations on kind to be issued in this country. His further travels again took him West. He crossed the continent with J. K. Townsend in 1832, thence visited the Mexican Islands and returned to Boston by sailing around Cape Horn in 1835, his companions were back in Philadelphia to continue his studies. In three years an uncle with great family of his own bequeathed him an estate called Wainwright near Liverpool, England, on condition that he reside there at least nine months a year, which with some adaptations he at length decided to do. The only man again visited this country, and since he could not be absent for more than three months in a year, he took the last three months of 1837 and the first three of 1838, keeping himself again in Philadelphia for part of the time. His death in 1837 was probably due to overworking himself in regarding a

heavy manual operations. Many amusing tales are told of him. One was recorded by a student, even from the interior which he was accompanying across the western empire, and likewise came back, even friendly Indians to search for him. These previously found him, looked on, and in his words for gifts and presents, but following him a great multitude, they feared to approach and kept at a respectful distance. Mameli, who had the greatest honor of Indians, slowly discovered that he was being watched well, watching his utmost movements, hiding in rocks and behind every bush and tree, finally succeeded in catching up to thought and captured his party and there they waited him at sleep.

Philadelphia, in the early part of the last century was noted as for a chief center of scientific activity, numbering among its notable men Prince Lucien Bonaparte, who was a distinguished supplement to Wilson's *Conchological Tables*; Deane, who accompanied Lang's expedition to the Rocky Mountains; and later Wilson's voyage of exploration to the Atlantic Ocean; Charles Bonaparte, the scientific naturalist and friend of Audubon, at whose house it is related that during a visit to the latter's house, after the household had retired for the night, Audubon hearing a softly noise issuing from his guest's room, on going to inspect his room, found Bonaparte sitting up there about the room holding in his hand the flattened remains of his host's favorite snail with which he was endeavoring to strike down a bed that had retired, and in which his eyes were now a species of putridness appeared. John Curtis was another of this remarkable category of men at Philadelphia. The wonderful collection of birds in the Academy was under his charge. Horace Walker of the whole in birds in the great nation of agriculture

represents the explanation for differing views on the Pacific trip.

But the most romantic figure in American zoölogy is John James Audubon, whose genius still inspires our artist. Numerous biographies may be consulted for details of his life, the most recent, that of Professor C. H. Merriam (1901) is the best one. His French parents gave him the fire and enthusiasm that carried him through all the hard and tedious work that marked his career through all the years until made his writings so most vivid, interesting, and sympathetic. Born in the West Indian island of St. Vincent, he was educated in France, and early resolved to master the art of painting in order that he might fulfil his ambition to prepare a series of portraits of American birds. In France he studied drawing under the great artist David, and returned to this country in 1795, taking possession of a home owned by his father near Philadelphia, where he became one of the galaxy of notable men of science in the early part of the last century. Here in 1801 he married Lucy Bakewell, the daughter of an English settler, and shortly moved to Kentucky and later to Louisiana. Audubon was kind to his wife and for a time he found himself obliged to paint portraits, much drawing and hunting on the coast his slender resources. Always he labored at his work of gathering eggs and specimens for his great work, the Ornithological Biography, which appeared in five volumes, beginning in 1825, and in which the best, of which the first and more elaborate plates of the Birds of America form the chief. In 1821, after twelve years spent chiefly in travel and exploration, he bought a home on the Flamingo River (now within the city limits of New York), where with his two sons and wife he lived for several the remaining years. He was less of a methodical scientific man than Wilson and Spence

particular interest with a love for numbers and calculated delights in the habits of birds and their daily ways, an appreciation which he was easily able to impart to his readers. For in this day when has not appeared in the compass of a single work so great a mass of statistics, descriptions of habits, and general observations on every bird, small and large, as are found in the *Ornithological Biography*.

CHAPTER II

REPTILES

Reptiles are distinguished from all other groups of animals by the possession of scales, just as mammals are distinguished by having a covering of hair, or at least some of it. The amphibians, that is frogs and salamanders, have a smooth skin, covered by few glandules, while reptiles have their skin studded with various pointed things which serve all scales, and are notably distinguished from the scales of fishes, each of which is a distinct structure, homologous with a tooth, and can be stripped off, as all lizards when young "shed" a part. Most birds have the fine divided scales of reptiles, but the skin is studded with folds of a different form, differing in different kinds of birds. Young birds, as the quail, have the scales of the feet more or less completely replaced by lamellae, which indicate a certain tendency to replace the feet. A naturalist's reflection will reveal that the only warm animals having the skin divided into scales are reptiles, as snakes and lizards. And this likeness is more than an accidental resemblance, for lamellae and scales, as we shall presently see, are perfectly comparable in their nature. A great scholar (Macleay, vol. i.) has investigated this matter, studying the scales of lamellae in connection with the scales of the feet. In the British Museum the same are provided in series with a variety of large and heavy plates which act as a support like lamellae. In our domestic pigeons some birds have lamellae growing out at the sides of the feet, and the same is true of various

beaks of birds. Their feather-growth appears to correspond with the scales. A comparative study of the developing foot shows that the scale seems to be a little projection of the outer horny layer of skin, while the feather seems from subsequent layers a little deeper, soon growing up to meet the scale which itself sinks a little. When the structure is nearly mature, it is seen that the feather is longer in the outer part of the scale. The inference is not that feathers are invulnerable scales, but that the feather is an outgrowth of the same layer and that both are parts of a single structure so that by suppression of the outer portion, the feather is left. This development of feathers from scales was perhaps one of the first steps in which birds diverged from true reptiles in the very early history of their evolution. And so soon the possession of a feather covering gave them an immense advantage and became a point, lower in their subsequent scientific development. For the first result of a downy covering that birds saw was the probable source of the early feathering was to prevent the escape of animal heat from the body. For fishes and frogs, for example, take their temperature from the medium in which they live, so that if the water becomes cold they have no means but to become equally chilled, and their activities are correspondingly reduced. In like manner reptiles, with their skin exposed to the air, take their body temperature more or less exactly from it. The result is that their geographic range is limited to the warmer regions of the globe, and as they approach the temperate zones, they are either wholly absent or the few species that occur are obliged to spend winter during the colder months. Birds, however, with their feather covering insulated from both themselves and the outer air, are protected as by a

care of double-crests, for the air told us by the feathers it so unconsciously let loose that the warmth of the body is not so readily lost. This double-crested crow was for sometime increased by pulling out the feathers by the action of certain skin muscles and thus making a deeper layer for insulating the air, as we saw Chickadees do when birds sleep in cold weather. The occasionally double-crested crow of varying soft fluffy plumage in the Chickadee's was undoubtedly five years ago in our region, when a long-legged stilts in midwinter was misled by a sudden change in temperature. The long thin birds could hardly have escaped somewhat of a quaking and the suddenness of the change must have shifted many of these birds, for they disappeared hereabouts from the neighborhood almost entirely. Flocks that had hunted the wheat and garden trees at Cambridge all winter, coming daily to feed-stations, were scarce now; and were their place-takings the two others following. Apparently the regular wintering Chickadees of the neighborhood had been almost entirely wiped out.

It is really true that the development of feathers, giving the gliding or sailing and other bodily warmth greater than the surrounding air, permits birds to range farther north or south toward the colder sides of the earth and thereby greatly enlarges the domain they may occupy. Moreover, instead of hibernating like our northern reptiles, they can sleep or remain active all winter, even in arctic latitudes, as long as sufficient food is available as sustenance for the body. This retention of heat increases the body temperature, and supplies an increase as well of the winged creature's activity, as that birds in addition to being the warm-blooded animals are at the same time the greatest self-starters. Their temperature normally is from 100° to 104° F. above

late as 1867, that of mammals was usually exceeding 10° F. The most work of Henslow (I recall) has shown that these birds generally considered the less highly organized or gulls, terns, pelicans, have a relatively lower temperature than the more highly organized species, both in Japan, Switzerland, etc. etc. There is also a marked diurnal range of temperature in small birds, which may be 12° or 15° warmer in midday; while in owls, which are most active by night, the reverse is true.

It is assumed that the first form of plumage developed by the various types of birds was down, downy young birds still go through a downy plumage as a first stage, and down is the simplest form of feather. When the second plumage is to be developed, could have been like it in all ways in part. In some of the more primitive birds which have almost not still being, we may perhaps find some indication of this former prevalent type of plumage. In the form the body feathers are found in the double.¹ For near the base of the web there grows a second web with double, scales, and barbs, as long as the others. This second part is called the alulae and is found usually in a reduced or developed condition in the feathers of many widely different birds. Thus some ducks have a flat other (quack) etc. etc. it is as long as the main shaft in the Pintail about as the South American Wren or Chatula. It is well developed in the Cinnamon and in Curlew. In its origin, it appears on the under side of the developing feather opposite the main shaft. It is supposed (1.) that this is an ancient type of feather, (2.) that many primitive birds may have had these double plumes, and (3.) that the simple type of feather is derived from it by a gradual disappearance of the alulae.

In a bird such as the Robin or Crow in which there are



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are distinctly smaller feathers, the visible part of the plume tip is made up mostly of the smaller feathers covering the belly and flanks and the larger feathers constituting the wings and tail. These are called "covert feathers," as they give the bird its general outline. But sometimes, nature has arranged groups of these feathers. Thus the long flight feathers of the terminal joint or band of the wing are primary, those of the second joint or part corresponding to our forearm are the secondary and are differently shaped, less stiff, and with more rounded ends. The tips at the end of the forearm or elbow are the tertiary. Each of these larger feathers is accompanied by a smaller one above and below, called a covert and there are several rows of these, distinguished as greater, middle, and lesser coverts. The long feathers of the tail are called rectrices from the Latin meaning steering feathers, in our own words long feathers of the wing called remiges or wing feathers. Just outside of the long feathers of the wing has a single row of feathers or major coverts growing at its base, as well as the large feathers of the tail has especially a major covert at the base. This arrangement was the primitive arrangement in the oldest types of birds, but Mr. H. S. Goss (page 4) has recently shown that there are some interesting deviations from it. For although it is known, peapicks, manakins, terns, and small gulls, nearly all ducks, doves, pigeons, rails, and others, the number of major coverts is the same as that of the tailfeathers, there are some birds in which they are more in number, and the added ones are usually at the outer edge of the tail, as if the latter had been increased in the number of barbs, while the coverts corresponding had remained. This is the case in rails, water gulls, ducks, geese, and swans. The opposite condition

In adult crows and jays the retinal fovea is itself the seat of the great and prominent, and in typical of the Passeres—what is the small foveola, or fovea, foveolæ, vitæ, vitæ, vitæ, vitæ, vitæ. In these the retina is bifurcated on each side, but the separation has no special value because it is displaced toward or away from the fovea.

In the wing of some waterbirds and some others there is a curious disposition in the retina that there is one great spot in each of the hemispheres. For in very many birds it is found that on reaching the larger optic ganglion one of the two of each hemisphere, when the fovea is reached, there stands the centre in its place but no second eye fovea corresponding to it. An instance in this peculiar gap that in previous has rendered a retinal centre, foveola, or arrangement with a gap, while the condition in which the fovea never does have a corresponding right fovea is called centre or typical arrangement. (There are other birds where the same thing—but not is enough.) This curious gap is found in loons, grebes, cormorants, terns, some pigeons, loons, ducks, and others. It is not found in loons, cormorants, terns, grebes, and other small pecking birds. Several theories have been advanced to interpret this condition. It is sometimes said that there is an intermediate stage, the fovea secundum, is either present or not, and that it occurs in so many groups of species that are only distantly related, it is taken to be a primitive trait more common to all birds. Of the many theories to account for this queer the most ingenious is perhaps that of Mitchell, who suggests that in the primitive bird the eyes of the fovea are the head in its own foveola/fovea against the horizon, one foveola along the finger, while that of the foveola has foveola/foveola in its own eye.

class. At the head of the series, therefore, an adjustment between these two sets of directions becomes necessary and was effected by turning the feathers in such a way that they formed the points of a triangle, a central space being formed, as in the column, two sets of stripes running in different angles to the mid-line axis. If the apex of the triangle were the fourth secondary, the two nearest homologous points of its base would define the axis line. In the later positions of the head with the shifting of the spots of the three digits and the series back as to the dorsum, the place where the triangle comes in will represented in certain birds by the third space of adjustment. In some of the small individuals I will further adjustment and modification of the wing feathers has effected the interest, so that the so-called axillary position resulting is a derived one, not the original one. The first point investigated of this matter is *Junco* (p. 14). The birds that the secondary series of feathers on the dorsum are composed of a certain number of feathers each, the number of which is enlarged to form the axillary, while the others form the primary. In birds having the gap, the first few secondaries were made of one more feather than the remaining ones, which he interprets as meaning that the wing from the effect due to the spots being shifted upward, so that in these the anterior feathers of each row have become pushed around to the outer side of the wing and thence the lower major coverts, while the secondaries of each row remain in enlarged to form the secondary coverts in the first terminal members is several shortening some of the secondary feathers, but in these cases it forms the true secondary. What appears to be the axillary now are standing in the opposite direction make a small secondary, which is an extended one and is hence completely developed.

There are many various modifications of the tail feathers that would be interesting to note. As two extremes one would think of the birds that spend most of their time on the ground, in storks and ostriches, which being one extreme (Pons, etc.). In these the tail has, as developed, as to be a more tail of like wingy feathers. On the other hand it is most developed in some species, as the three-toed stork, the shore larks, certain Terns, and the Frigatebird. In these latter species it is the enormous tail-feather that is longest, and it is possible that it is advantageous to the bird in giving greater leverage for making the quick changes of direction necessary in evading their voracious enemies, just as a long steering rod is used by the steerman of a ship when he manoeuvres the craft with the greatest speed and least loss of momentum. The tail feathers of woodpeckers have the middle point specially reinforced and pointed to act as a brace against the trunk when the bird is at work; while in the Chimney Swift all the tail feathers have reinforced tips devoid of web, thus acting as a support in this case also. Many other interesting and unusual facts about the tail feathers and their various uses should be described. In some cases it seems fairly obvious that the long feathers of tail are sometimes also developed solely for ornamental purposes in display, as in the Peacocks, which spend not in quiescence but in enormously lengthened events. But in the Turkey, where this is the case in the tail itself, there is an interesting contrast in the shape. Even in this bird the tail has not become so much developed that it cannot serve as a perfectly good steering device in flight, while at the same time it serves when the other function of a banner is display. The tailfeather of even in some separate functions, in a slight degree it not ab-

very easy, for there is often a railway bar man to answer the chief function as the representative of the union. The lantern song song is sung by several of the African Wives-singers. In one small species (*Chrysomitris*) two of the upper tail-feathers are immovably enlarged and serve out with their bases vertically placed. In these instances there is usually shown at least between joining the top and the body that it is convenient to perch having the tail on the opposite side of some other one, looking like an many other wren-like birds, but the long flattened feathers do not manage well to stick. In a still more pronounced in the so-called Black Wren, a common bird in East Africa. The females are like the males, resembling one another of a female Redstart in their brown and black markings. The males, however, are of about the size and appearance of a Redstart Blackbird, except that the tail feathers are very long, over a foot, and end downwards at the tips. These are partly concealed and are used in a peculiar form of display which was well described by the late Colonel Kennard. The birds prepare their dancing floor some two feet across in a grassy place, turning off the grass blades and laying them on the floor. A single cock bird alights in this ring, and generally with wings spread, head thrown back, and tail drooping, hops up to a height of about two feet and drops back again, showing off the plumage in this effect. When it comes to flying off, however, it makes a dash. It was once a small flock of females and a single male fly off together, but though the former were checked out of sight, the young male, with his long plumes undulating behind him like a line tail, was quickly left in the rear, and was at last stopped by the strong following breeze that he slowly came down and dropped to the ground.

Perhaps the biggest feature of any bird on the east and mid-point of mountains of the Eastern Mountain, a species of the wooded and steep mountain valleys of central western China. This beautiful bird is exceedingly rare, flying slowly in some of the pine and oak forests and under foliage of its mountain home. Its flight is like a machine, with nearly double the speed of a Common Pheasant. Those who have observed it say that its extraordinary speed is brought into use during flight when it wishes to make a sharp change of direction. At such times the bird throws the tail up nearly vertically, turning its expanded surface and thus at the wings sharply against the air, which causes the bird to drop at nearly right angles to its course into some deep covering. This "Whispering bird," as it has been named, is therefore often all of value in the bird in the steep valleys of its home in following it to take suddenly back into the jungle.

Among our familiar species, the single elongation of the feathers on the back of the head is, perhaps the commonest change observed. This is the Blue Jay or the Pilgrim Woodpecker where is a simple crest. In some of the birds the crest is developed in two parts, one at each side of the head; the mottled down of the Snowy Owl, Long-eared Owl, or other species. It is interesting to find similar forms in one of the "Whispering-like birds," a group whose relationship to the rest is undoubtedly close. On the other hand, the crest is present in addition but removed to the Upper Tail.

While the crests that come in elongation the form of the long feathers are usually short, there are some very remarkable exceptions. Thus the wonderful fan of the Peacock's tail, or some suppose, the tail of the bird, but the

upper tail-coverts, remarkably enlarged all they far exceed the tail itself. There may be parallel developments of the primaries as well. That there is a certain similarity to the *Heterostegus* (Night-hawk) in which the outer primary, after forming a short web, branches a very long slender shaft, so that in the bird seen the two shafts run on each side, far along behind giving the impression when first seen in the dark of a large bird flying past pursued by two big snakes. It may be that these are of value in the soaring motion of the bird, but it seems more that there may be loss of a disadvantage than would in other species, but very clearly good mechanism found these birds are finding it difficult to hit with a design, and discovered that the flapping legs on the side of the long slender shaft are apparent against the moving target so that they practically were aiming too far behind the bird itself. It is possible that these appendages would have a similar disadvantage when on a spreading web.

In addition to the summer feathers, giving the general shape to the bird there are found in many species, as particularly this water covering, a more or less downy layer of small fluffy feathers or "down," similar to the down which is a greater or less fluffing form (the first covering of young birds). There is a very interesting relation between these two sorts of feathers for not only does the downy plumage precede the more advanced stage of summer plumage but the young feathers of the young bird develop in the same way as do the downy feathers of the old bird. In other words, down, whether found in young or adult bird, is to be looked upon as a primitive kind of feather, and we may suppose that the whole plumage of the earliest ancestors of our present-day birds was chiefly of down. The broader

and collar feathers were probably developed first in the history of their race, for in the individual bird they are provided by down feathers except where there have in some late species become suppressed.

Plumage.—From the external appearance of a bird one might easily suppose that the feathers grow equally from all parts of the body. But except in a very few of the long species, including Charitons and their relatives, as well as Puffins and the South American Boobies, this is far from being the case. Indeed, it is found on plucking a bird that the feathering is in certain definite feather-trunks (or plucked feathers which are areas of bare skin I named *epithel*). The feathering of a bird (that is the distribution of feathers on its body) is spoken of as *plumage*. It would seem reasonable to suppose that the feathers of most birds had their plumage evenly distributed over the body just as scales of reptiles are. This would be more likely for small feathers as small, e.g., in Puffins. With the increase in size of the feather and the consequent increase in the space between, it becomes possible to notice the same fact. Hence it is that on most downy young birds of the present day instead of these feather-trunks or *epithel*. There is much variation in the extent and shape of these trunks in different groups of birds, even among those that in other important characters are undoubtedly closely related. But that is that birds as a group have as much of their external parallelisms in common that it is difficult to pick out any single trait which may not be similarly developed in birds otherwise more distantly related.

But in general there are four chief feather-trunks usually present, namely:

- [1] The great tract which covers the head, most of the



REPORT: PHOTO OF A PERSONAL PHOTO

1. When we were first in a (personal) photo, it was taken in a room in a room. 2. When we were first in a room, it was taken in a room. 3. When we were first in a room, it was taken in a room. 4. When we were first in a room, it was taken in a room.

John Smith

When we were first in a room, it was taken in a room. 1. When we were first in a room, it was taken in a room. 2. When we were first in a room, it was taken in a room. 3. When we were first in a room, it was taken in a room.

back, and as seen along the middle of the back as the base of the tail. Sometimes this tract is interrupted by a distinct space dividing the back into fore and aft areas, or instead there may be an oblique division on the back from larger to smaller feathers. Sometimes this tract is divided lengthwise in the middle.

(1.) The dorsal or breast tract, which features each side of the breast, and hence is wider or narrower area here in the middle. In the sides of the neck this tract is sometimes continuous with the spinal tract and is often broken at the breast end.

(2.) The humeral or upper-arm tract, which is always present as a band of pointed feathers on the upper surface of the upper arm and at nearly right angles to its length.

(3.) The pectoral or thigh tract which is a very similar band crossing the upper side of the thigh.

In addition to these four main tracts the wings and shoulders are more or less fully feathered, and various birds show small modifications.

Feather structure.—If we consider a contour feather, we find it to consist of a central supporting axis, the shaft (rachis), the lower part of which is feather and transparent, with a hole hole on the end face which projects the gross rhombic membrane feathers have develop. The upper part of the shaft has a somewhat square cross-section and is filled with pithy substance, while growing out from each side in the main web or vane of the feather. The web of the feather is really pulled apart, and is seen in cross-section as a long row of holes (in cross), one row on either side of the shaft. Each bar-feather is supported by a small feather and there is a row of bar-feathers (or under) on either side

corresponding to the hooks. These barbs therefore spread out on each side of the hook parallel to the main shaft of the feather, and are seen as overlaps. The set of barbs on the side toward the tip of the feather overlaps neighboring barbs, and contains small hook-like processes (I found) on the under side to take similar hooks on the upper side of the neighboring set, so locking the entire web together. In downy feathers the little hooks are lacking



FIG. 22

Structure of downy feathers. (a) *a*, part longitudinal of barbs (b). (c) *c*, central shaft of feather (d). (e) *e*, barbs on the under side.

John May

and this is true also of many plumaceous feathers as those of the quills or the Egers, so that the barbs are not locked together and the feather falls out. — There are many ways in which this structure may be modified to produce peculiar feathers. Thus the hair-like feathers which we drop off soon in children before molting are reduced feathers which in their course of development have lost the web and now remain merely as the slender shafts. They are called filoplumes or thread-feathers, and in some birds project beyond the vane of the feather. The hair-like barbs in some types are of this nature. In the Birds of Paradise the long wattle feathers seen in the tail of certain species are merely the elongated middle tail-feathers from which the vane has disappeared. In some American *Alouatta* (Howler

of the scapula, strongly reduced in Kingfishers; the alulae have a square dorsal or side bar on each or none near the end of the very middle tail-feathers, so that there is a longer-shaped place forming the tip of the feather. The curious thing is that in immature birds the feather is entire, and gradually loses the posterior part of the web that comes out both at right angles below the tip, bending in front as it falls. It has been lately said that the bird actually picks off the barbs of this portion with its beak, but the real explanation seems to be that barbs rupture they are somewhat brittle and break off during the operation of preening the feathers. Trapezoidal feathers are found in some other birds, among them a new kind of Plover.

Before leaving the subject of down, it will be interesting to describe the peculiar position of those feathers called "parula-down," that occur in certain birds, such as herons, bitterns, hawks, and in the Woodpeckers of India. This type of down-feather is somewhat oily and of a peculiar brittle nature, easily breaking up into a sort of powder. Though such feathers may be scattered through the plumage and usually overlooked, in the herons and other birds just mentioned they form definite vertical patches: one in the middle of the breast and one on each side of the breast back. Wetmore (1929) observed that in young herons these patches are used by the birds in lubricating their plumage. The bill is run through the patches and then the large feathers passed through the mouthpiece and the under plumage rubbed over. In the immature stages the oil gland of the bill is not small and underdeveloped as in of use for oiling the plumage, so that the function of the parula-down patches is to take its place in the early life of the bird. Wetmore suggests that this oil gland may even have

originated from a pair of these smaller feathers, the many minute and short of which may have combined to form this single large gland.

The developing feather in its earlier stages appears as a minute pin-like structure, which on microscopic examination is found to consist of a dichotomous cellular (papillated) outgrowth from the growing tip of the feather. The young featherbeds are progressive in growth about the central papilla which sinks into the skin and forms a projection into the base of the feather to supply it with blood during growth. The first barbs of the growing quill are in a line around along and living without hooks to hold their adjacent barbs together. But are are drawn by the breaking away of the enclosing sheath. They have but a very short suberlike base. When the whole feather again is grown, the same papilla becomes again active, and the next feather to be built is substituted, at the same time it is started out on the tip of the new feather, and is finally rubbed off, as the growing part of the feather reaches its full size as "new" or immature, and is immediately cast off from the development of the blood, and is really dead, just as the cells of our finger nail may be said to be dead, and no change in color or form due to growth can be observed take place in the feather. It is quite common to see the living quill at the base of the feather barbs again active and a new feather is formed following the mode of the old. The same experimental investigations seem to show that a new papilla is formed with each moult rather than that the same papilla again again becomes active.

The moult (change) of birds is often a much more complex process than might at first be supposed. For not only do different species differ in the number and time of

moult, but there may be individual differences due to sex, age factors, as age, sex, condition, and so on. Very reliable studies of this matter could be made by following the plumage in birds that have been individually "banded," and caught for examination at frequent intervals. Careful notes made as they come should, however, be checked by the examination of preserved specimens, for it will inevitably occur that additional points will come out that cannot be done in the field. The reference collection is almost indispensable in any serious work of this sort. Studies of rapid birds, though increasing, are of relatively few value where rapidly made to reduce the entire plumage of the bird so that the molting process is seriously interfered with and is likely to be quite different from that occurring in the normal state. American ornithologists have been interested in the study of plumage change in birds. The works of these (1) (2) (3), Chapman, and Dwight (4) (5) may be especially consulted. While an extensive treatment of the subject cannot be given here, the following general facts are for review.

(1) All our smaller land-birds when adult moltings of plumage are passed usually at the close of the breeding season, whereby the entire plumage is renewed. In this way the "fall or winter" plumage is renewed. Hence sometimes this moult is "physiological necessity," lower moult has no.

(2) In many birds there is a spring moult whereby a fresh breeding dress is donned. This moult commonly calls a partial change, but some of the feathers of the previous year are retained. An interesting exception of the previous moult upon molting a winter and spring moult in that a fall and second moult may have dissimilation in color due that adult plumage is acquired. The male Greater Tanager in

in that white plumage is often with brown wings and tail. In the following spring it moult to the familiar red and black except that the brown primaries and secondaries of the wing are retained, and do not come in as black feathers till the second summer. Occasionally individual birds of a species may continue to moult every spring, while others of the same species do not, either reaching the white plumage. Both species may perhaps be in a transitional stage of moult, but whereby the number of moult is in process of reduction. (An apparent exception is, for the latter, least perfectly established in the case.

(2) In a male the large feathers of the wing, on the surface, in the life of flying birds, are retained less often than are other parts of the plumage, and the regions under in which these flight feathers are shed, frequently isolated among related groups of birds.

It is obvious that the number of different-looking plumages that a bird may have, depends on the number of moults required to reach the final or white stage. And these different steps may be looked upon as representing in a way some of the stages passed through by the species in its evolutionary history. Thus our common Robin in its first plumage is speckle-breasted, recalling the condition found in the young of many other thrush-like birds, and one still retained in the white-placed Thrush, for example, whereas the white Robin may be thought of as having evolved beyond this stage and entered upon another stage in which the breast is wholly red.

The loss of a feather seems to act as a stimulus to the growth of another. Thus it is that in Germany the crops of feathers used to be plucked in old times from the same spot in the course of a year.

Jaeger has suggested special names for the successive plumages of birds. The first of all is called the *downy* stage, in which the young bird develops downy feathers only. This plumage is most useful and enables the fullest expression in the young of certain birds that later the same may develop a few feathers, such as down, feathers, semiplumes, the true semiplumes, etc., all of which have a thick covering of down, as familiar in the chicks and ducklings that still sleep under the brooder cover. In many of these birds the down is a highly specialized down, dominating very strongly the bird's background so that the young bird can hide in, mainly in almost any natural situation. In other birds that spend a longer time in nests, the downy plumage is not so well developed, and its expression is often but a mere hint, as the bird is back, for in these birds it is important that they develop quickly and enable their light feathers as well as feathers that protect in migration, as to shift for themselves. In all cases they skip this stage as rapidly as possible. Indeed, as is shown in *semiplumage* and *hemiplumage*, and more when we doubt will altogether suppose it, is subsequent stage of progressive evolution. In the Australian Bush Turkey, it is said, the stage is passed through before hatching, so that the downy plumage is not found in the young except in the egg. This process of throwing stages in development behind and further back into the earlier stages of life is called *antimimicry*, and when finally results in the individual skipping the particular stage altogether.

The normal-growing of feathers is called *cal*; the first or several plumage, and consists of various feathers, which carry out on their tips the down of the growing plumage. The wing, and tailfeathers involved by the young bird of this first set of moult the same character as those of which

birds that the body feathers are usually more fully. The plumage is varied during a varying time, there are few smaller in some birds, but in others it may even replace it.

(1) *the first winter plumage*, in which all the feathers are of the same nature as those of adults. In many birds this plumage is acquired by a complete moult, as in the Howard Loon, Red-tailed Blackbird, Grackle, Texas Parula, and the woodpeckers. In most of our smaller species, however, the tailfeathers, longer wingfeathers and their own are not new feathers but are produced from the growth of the juvenile plumage. It is in this first winter plumage that the birds acquire their own features. In early spring, probably in connection with the increased activity of the sexual organs, there occurs in most birds another moult, more or less nearly complete, whereby the bird in its first spring attains its length of first summer plumage. Sometimes, as in the Redstarts, the winter plumage is renewed, but in most small birds, the wing and tailfeathers are held over from the previous plumage. In some, only a very few of the throat or head feathers are renewed in this moult. It appears that those birds that differ markedly in the appearance of the spring and fall plumage, undergo the more extensive change at this moult, while those which differ little in plumage the first round have a less marked moult. An interesting case is that of the Redstart and the House Wren, where birds spring plumage is not that identical as in the other birds the tips of the new spring feathers are kept behind and of the previous rather than the rest of the season. They very soon break off and the result is the remaining black and white lines of the breeding plumage. The last black throat of the common House Sparrow differs widely from the breeding of the feather type of this year.

The young birds of the previous year have now reached adult life, and it is probable that nearly all the smaller species may have taken a year off, with the exception of those few capital plumage. In some birds, as our *Thryothorus* (*Chondestes*), the most beautiful plumage is not reached until another spring or two, after extensive summer and spring moult. It is a question, too, whether some individuals of certain species ever acquire the perfected dress, but remain all their lives in a less brilliant condition. This suggestion is illustrated, for example, by the fact of the relatively small proportion of bright-colored male Pine Grosbeaks in the flocks that travel up here in winter. Some old birds of known age might show much lighter plumage in this case, and the problem is not that new birds are excluded by old or limited birds.

To sum up this matter of moult and plumage the following table shows their relations:

State of Plumage		State of Moult	
1 a) First dress	1st yr.	C a) pre-juv. moult	
1 b) Juvenal plumage	" "	C b) post-juv. moult	
1 c) First winter plumage	" "	C c) first pre-adult moult	
1 d) First capital plumage	" "	C d) first moult to post-capital moult	
(First a year off)			
2 a) Adults in second winter plum.		2 b) Adults in second pre-capital moult	
2 c) Adults in second capital plumage		2 d) second post-capital moult	
(First two years off)			

It should be understood that while there are the general rules of plumage, different species show great variation in the degree of completeness of all but the postnuptial moult. That is, the entire plumage is always renewed after the breeding season by the annual complete moult, but the postnuptial moult is likely to be incomplete, so that the breeding down may be supplemented or partly or even partly shed of feathers. Of the many interesting variations in time and amount of moult, there is one especially to be noted in birds. Among the ducks, however, we find that at the second post-nuptial moult, that is, when the birds have bred, all the long wing feathers are shed at once in some species, so that for a time the birds are incapable of flight and sometimes entire or extensive numbers until the new feathers are grown. Many water ducks at this time develop a new plumage which may closely resemble the body plumage of the female, so that it is given the name "indefeathered" plumage. It is not unusual till spring in some species has passed the body feathers are shed in about two months, so that by summer the bird is once more in its familiar bright plumage which goes through all the next breeding season in new. This is a hastening of the post-nuptial moult, so that if better is lost between or earlier instead of in spring, and while it may have gained a feather or two in plumage, however it resembles the adult plumage of the female, it may be that nevertheless there is some other reason for its being premature. It is perhaps not unlike with the early moult of many species of ducks, so perhaps it is a plumage in its way to complete replacement so that in the course of evolution the character of the original winter plumage will be so shortened that it will disappear altogether and the plumage that once was in-

usually only in spring, will be used in studies as the second principal month and he goes till the next principal month the following year; that is, he goes on from 1 stage to the next stage about every year. In fact this is exactly the condition found in some of the most highly organized birds, as even the common House Sparrow, which usually has one a year. This is only one of the many interesting problems connected with the subject of birds.

CHAPTER III

THE COLOR OF FEATHERS AND THE COLOR OF THE SKIN

There used to be a misconception. What makes a frog and a toad? The answer is: His skin. But if we remember what makes the bright or dull colors of birds and why their plumage is thus marked, the answer is not so simple.

The basic cause that is the growing feather that developing feathers make their form and coloring matter, when which they go through a process of hardening, the walls of their minute cells become hard and the living contents of the cells move to the top, so that the mature feather is in a way a dead structure, like our finger nail. The coloring of the feather cannot therefore be changed by the coloring in of new or different coloring matter, for there is no mechanism for this. The only way in which the appearance of the plumage can be changed is through wear, which may break off the minute tips of the barbs or barbeds, exposing other coloring that already existed but was hidden by them.

Pigments.—The beautiful colors of birds' feathers are due chiefly to two factors: first, the pigment produced inside the structure of the forming feather, and second, the structure of the feather itself: that is, the light reflected from the surface of a feather may produce an effect of color different from that of the coloring matter in the feather itself. To illustrate this better, again, when the downy feather of an birdy-bird, grows it under the microscope

with a layer of oil to submerge the feather surface, and on looking on in the light transmitted from below, the layer of pigmented granules inside the feather structure is seen in the reverse. In the case feathers of crows the color appears blue because the layer of brown pigment is not directly visible but the peculiar structure of the feather structure producing intense reflecting surfaces by means of a layer of oils above those containing the pigment.



FIG. 17

Diagram (a) shows the structure of a feather, and (b) shows the structure of a feather, with a layer of oil above the granules.

Diagram (b) shows the structure of a feather, with a layer of oil above the granules.

A very recent writer (Kesteven, 1904) has given an account of the ordinary pigments of birds that seems fairly simple. There are of two sorts (a) melanin (meaning black) and (b) pheomelanin, meaning only or dark colors. The melanin are present in the feathers as minute granules and are soluble in concentrated acids. They are of two sorts: (a) eumelanin, which is black or blackish brown, and soluble with difficulty (the pigment these granules are apparently large). This sort of pigment is combined with other coloring like a tendency to appear at the base and of the feathers. (b) The second sort of melanin is called pheomelanin, and varies from reddish brown to dull yellow, or may run in almost colorless. This sort of pig-

more often regularly distributed in rows of granules present some of the siliceous whitish color. These two kinds of nucleolar granules are chemically similar and the lower may even be the same as the former, only greatly reduced.

The lipochrome are not like the nucleolar granules, but are like colored cells. They are soluble in water as in alcohol, and give out of two chief series: (a) monochromatic (or almost yellow) of pure yellow color; and (b) anisochromatic (or colored cells) of pure red color.

When the blood circulation is almost present in the ordinary fashion, the bird is black, but if the amount is small the color is less brown and becomes blackish-brown, as in the young *Myadestes* (black). The phenomenon of brown pigment granules gives the melanochromes and yellow-brown colors, which are brown or pale according to the relative amount. Black colors, however, are the result of combination of one or more of the nucleolar, lipochrome, and colored granules. Thus:

1. *Spencer* combination may be (a) of both sorts of nucleolar, which gives black gray like the back of a chicken if concentrated, or olive brown if dilute; (b) both sorts of lipochrome present together giving orange (like the crown of the King-bird); (c) the combination of nucleolar and anisochromes is frequent and gives yellowish olive green if concentrated, brownish olivaceous if dilute. Thus by the gradual disappearance of the nucleolar (lipochrome) is a direct trace of the *Empidonax* (Spencer) the bird becomes a pale gray-brown on the back.

- II. Figured + colored? Some of the feathers when examined progress in yellowish-brown and blue with the yellow green is produced by the combination of carotenoids, melanin and porphyrins. The structural modification also consists of a deep layer of pigmented cells near those carrying the pigment and more as a sort of reflecting surface.

Evidence shows as in the male feathers of pigeons are found to make down the dark pigment granules near the feather-tips being spherical instead of the usual rod-like form. Might making these spherical granules is broken up and the other called "Purpure's claps" is produced, with various tones.

There is another remarkable and unique sort of pigment which is found only in the three genera of *Phasianidaceae* or *Trogon*, a group of Indian birds, long-tongued, as found in the culture, the commonest species of which are a beautiful deep green, with slightly (scaled) heads, and with the ornamentation of the wings a dark-brown color. The discovery of this pigment was accidentally made by Mr. John Lawrence in 1841, in India. At the time of the accidental color he noticed that these birds had the forewings and middle wings in the lower lower branches. They had which he had noticed by the wing exposed, and great was his surprise to find that the inside of his hand was colored a strong red. Some days later he repeated the experiment with these same birds caught in a similar condition, and found that he could rub the red pigment off from the feathers, rubbing them to a pale rose hue. Lawrence believed that when the feathers were dry the red pigment was removed but this is disproved by his brother

Choate [1891], who has handsomely summed up our knowledge on the subject. It appears that this red coloring matter is really dissolved in water (but not hard) water, or water and soap. These birds kept by an Englishman "washed themselves nearly white" in the water given them to drink. Sir Arthur Choate dissolved out some of this coloring by use of distilled water or weak ammonia and found that by counteracting with weak hydrochloric acid the crimson pigment, which in culture remains (from Taiwan the mother stock), was precipitated out in gelatinous form which, when collected and dried, forms a deep red mass, with a surface lustrous of purplish. It is insoluble in alcohol, ether, benzol, and other usual solvents of oils. It heated in the boiling temperature of mercury to drive off any oil, and then treated there is finally left a blackish salt, amounting to about $\frac{1}{10}$ of the original weight, which is found to be made of copper, about 7% of which is pure metallic copper, and shows a greenish bloom when treated in benzol. Traces of copper are found in other animals and in plants, but let others find out how they find out their color as it, though it was mistakenly reported that *Amphiprion* was found also in a Philippine colony of a different family.

Choate and Barak [1894] have handsomely shown that more violet color is structural. In some cases, however, it may be the result of actual violet pigment. They have succeeded in isolating such pigment in the *Centropyge* and in the *Queen Pigmy*, and have shown that of the former species, that of the latter species since the Latin name of these birds.

A pure white feature is now devoid of the pigment granules in its structure. The many minute cells which make, in homogeneous fashion, build up the structure, collect

light from their various surfaces so that the feather appears white since most of the light falling upon it is not absorbed. For it is the absorption of certain of the rays of the light-spectrum by pigment that gives the color to an object. We see only those rays that are reflected back to us. If all the rays are reflected, the object looks white; if the red, yellow, and green are absorbed, and the blue only is reflected, the object is blue to our eyes, and so on; while if all the light is absorbed, the object looks black.

We may now inquire, "Of what use are color and pattern in birds?" There was when man believed the purpose was to delight human eyes, for man saw all things around the bird's nest? Yet, even so, it seems impossible to have appeared so completely for the good of man. The solution is a large one, that of environmental possibilities, yet achieving better appearance the careful bird observation by observing eyes.

In a general way birds may be said to reflect in their plumage certain lines of their surroundings. Thus, many are birds are black and white, as robins, goldfinches, vireos; or black and white, as mallards and herons, whose color arrangement is of relatively simple light and shadow, day and eve. Mockingbirds make foliage tend to be yellow or yellowish-green, with black markings, such as many of the warblers, goldfinches, vireos, and vireos, whereas others reflect shadows are dull brown, as Song and White-throated Sparrows, Winter Wrens, various thrushes. Other birds seem totally to defy such generalizations, so that it is difficult to interpret the value of their coloring in their life history. The whole matter is not to be studied carefully.

The subject of avian color has been experimentally studied by the late Sir John H. Thayer (J. H. Thayer,

world, neither easily has been considered further discussed by certain English ornithologists. In his considerable book writing both the experiments and observations, Thayer takes as his main theme that all coloration in the animal kingdom is due the purpose of concealing its owner. But we have seen that a single organ may serve more than one purpose, so we may expect to find that some colors are for other purposes than merely concealment.

The diamond is hard on its object from the background either (1) because it reflects a contrast in coloring or (2) because it stands out in relief through the effect of undulating produced by shading. It must be said that a bird standing motionless is likely to be effectively concealed against a considerable variety of backgrounds in nature in the case with which the same bird is visible when in motion. The concealment of the motionless bird is due more relative of its coloring, especially the background against which it is seen. A simple case is that of the Night-hawk, appearing motionless among leaves, dead sticks, and in shaded areas. The change seems almost a continuation of the background. This class of coloration may be called "mimetic"; the bird mimics its surroundings, and as long as it is still, it passes easily as a portion of them. There are some different degrees in the degrees of mimicry. The Night-hawk has developed this method well up to perfection, and it well hides their ground-hawking habits. In the case of such birds as Quail and Ruffed Grouse the general color and texture mimicry of the background are imitated, rather than in colors alone. There is a slightly mimetic effect even in the case of such birds as Starling and House-sparrow which are often difficult to detect if they stand



FIGURE 1. A photograph of a rock face showing numerous small, light-colored, irregular shapes (possibly fossils or mineral inclusions) embedded in a darker, more uniform matrix. The overall appearance is highly detailed and granular.

spatial among black branches, for they look like something that one can, actually, grasp or breathe.

But while the Nightshade is characteristically projected by his artistic phantasys, we must recall that his legs are very short, he squats down on the ground, and his phantasy is in actual similarity with his surroundings. "When of the long-legged bird does one speak?" An additional difficulty comes to him, for however little the bird-like body he showed shows the surface, it casts a shadow, and that is equivalent to showing not its self, as being visible to a sharp eye. The phantasy called by "super-sensuous" shadow, and that brought to the notice of naturalists by him, was more than play. I recall the famous artist's demonstration of his discovery as a member of the "American Cinematograph" Union in Cambridge many years ago. He showed us three pictures, first, as a white wall represented a lion looking above ground. As a distance of sharp focus had the middle picture was nearly invisible, though the man could not be aware of the surface shading of the under side. After sufficiently supplying his audience, he stepped forward and by a turn of the eye he moved the picture, when he was surprised to see that the visible lion's lower side had been painted white, thus counterbalancing the effect of the dark shadow. So the lion then looked with characteristically ingenuously surprised, it had been "standing in its own light." This he told is the principle of counterbalancing, the effect of which is no denying the appearance as relief by counterbalancing the dark shadow of the lower side so that the object does not stand out from its background in strong relief. It is a widespread method of artistic counterbalance and is often advantage of by a

great variety of species. Thus it is that birds with often brilliant and dark bodies are so hard to see when they remain still against an appropriate background. Woodpeckers, grackles, many sparrows and a host of birds that feed much on the ground are commonly colored in this way. Of one very special kind of white wings we observed, I think it was Mr. Cooper also who remarked, in speaking of this type of coloration, that a pale breast up here is not necessarily for the purpose of giving concealment, but is, in fact, a camouflage in another coloration. The main probability is that very many birds have developed their concealment in response to the principle that darkness of light produces a smaller difference in pigment, as does the dissimulation of individuals that have strong pigmentation because they stand out in greater relief than the more less conspicuous members to represent their kind, and so gradually the exquisite and beautiful was reached.

Another interesting color effect is pointed out by Thayer in birds such as King or Herons, egrets, as many shore birds such as plovers, Pectoral or Least Sandpipers. This is the perspective effect of the attitude of open which we observe on the lower part of breast and throat or on the sides, that they are on the back, neck, and head. As one looks at a bird from a little distance against a fair horizon, the lower markings on the lower areas of the bird change in with the background of the scene, while the line up markings correspond to the apparently smaller details of the more distant portion, an effect probably of pure color division as an action that we are used to considering objects in perspective. In Thayer's own words, this type of representation is actually already coloratively decided, is a representation of pattern beyond the colored, often

ing is no longer visible as a flat plane (that is, without its life) or as merged into the scene behind it.

Additional examples of the reproduction of background patterns in the plumage are readily brought to mind. The gray-patterns of alternative dark and light stripes simulating light and shadow of masses (background) blades are beautifully illustrated in many swamp-loving birds, tinies, Woodpeckers, Swamp Sparrows, Swamp-voiced Flickers. The striped neck of the Heron is a familiar example, and many have probably seen the wary bird stand motionless after daylight among tall grasses, the pattern of its mottled neck throat simulating the light and shade of the stems.

With an artist's authority Cooper describes the camouflage type of plumage with its abundance of contrasting markings as a sort of background patterning, comparing the details of a swimming Wood Duck's plumage made up of the various elements of its surroundings—that the shimmering light and dark wavy lines on the back simulate water like those on the side of the swimming bird; the orange patch about the eye seems with a bit of a mottled throat beyond, where streaks in the plumage pass on planes of light and other dark markings merge with other elements of the background. The white or variegated bird such as the Chamaea-winged Warbler, the yellow-crown simulates a sun disk on a leaf, the black eye-line a dark twig, where dark marks are shadows, the dusky side is mottled bark. Besides its natural settings the bird is protected by having a detail of coloration like that of its average surroundings. All this is doubtless true,—indeed, is demonstrable,—but is only one aspect of the matter. Among tree-dwelling warblers is very great variety of color patterns seems to be found, made up of these same color elements in different

combination. The Cape May Petrel, Piping Plover, Blue Grouse, Black-throated Green, and Purple Warblers all have yellow and green, light and dark markings, some with chestnut tones added; and, for aught we can see, appear to get on equally well. As distances of visibility increase they all would seem equally well to be surroundings among leafy edges. In other words, there are many combinations of these patterns; that they would produce the same observations about as distances of, say, five feet or so. There must therefore be an additional significance to the fact that these same color elements are differently arranged in different species. Thus, I think, distance is a useful aspect of such color patterns, namely, that they have (1) an advertising effect at visible distances, and (2) an individual effect when at close range. A familiar example is the robin, which at one hundred yards looks as greyish-brown as a chicken, but at a few feet shows a handsome pattern of stripes to a watching youngster that glances at least human eyes. May it not be with many groups of birds having similar color elements in their plumage, that at distances of ordinary range they are like unmarked snow or low effectively by being pure of their background, while at close range the differing elements of their overall patterns are useful to the different species for display at close range or for help in identifying them, or for other purposes?

Still another aspect of coloration is that producing so-called "negative" patterns, which, while distinctive still, serve to put the body into unobtrusive places, so that it presents no marked thing to full view. These markings are there, they hold and last long. A Downy Woodpecker with its black head shows a more broad display than one

wonderfully when standing among gardens with their rounded masses and alternate light and shade. It is this principle that was widely used during the Great War to reduce the visibility of warships by breaking up their lines by painting into contrasting and irregular planes of undulating shape. An interesting detail is that of over-riding the eye is black. This bright black-black starts right where he conspicuous and serves as a solid-line mark when it was considered as marked by a black patch covering more or less of the side of the head. It does not follow, however, that all birds as marked have used for this particular as indicated that they are very much more concerned with as without a dark, conspicuous. It is here that observation of the living animal in its natural haunts is absolutely essential as a correct statement of the part played by coloring as a useful adjunct to the bird's equipment. It is particularly possible that in many cases the coloring is quite unimportant for protection. Thus one does not readily perceive when that a bird like the Turkey Vulture has markings that undoubtedly have function. In a great majority of cases we know very little of the actual function of birds, but they escape from them as they often their protection derives not unimportant. It must be known in which case, that case, and especially the white case, is a comparatively recent factor for absolute destruction, so that some of the elements named are primarily meant for assisting his parents.

They are frequently emphasize the point that certain colors may be of use only occasionally or at particular places and at such times serve their purpose, just as a (or) pattern the glass-shaded wings when in the act of folding.

There are many other ways in which color may be used.

tail. While a bird is moving in any rapid motion, constant change being now by wonderful means, it is possible that even as much change is possible as might be talked by some scholars. Take a house hawk, says 'Tayer', and mark it as it is in shadowed black and white, and you will be surprised to see how much more difficult it is to hit. He is made better look with his variegated beauty of black, white, and buff more for beauty to man than of his own all black. And what new use can be made by a hawk? Possibly the white makes one wings and tail so commonly seen produce a similar effect to a moving bird. The same method indicates that the dark-and-light coloring of a Sharp-shinned Hawk is also nature's best hint of this bird's true complexion, for the color pattern that is well with the alternate light and shade of wings in the house. In this case, therefore, the appearance would be partly concealed by its pattern, just as in prey, so that the eye makes both ways. There may even always be some that would make other all very little difference in an actual chase in full view, and I personally believe that this is often true. But the more we see the actual pattern and compare its shape, the more it shows more than in the critical moment that have thing may now the make be lower of the prey. As a single instance, I directed you to see a Sharp-shinned Hawk in close pursuit of a Cherry Woodpecker, both birds showing green in Cambridge street. As they passed a few yards from me, with the hawk hardly a single foot behind the woodpecker, as if reaching its prey, around a single head and pendant set of moving droop, partly shading us, but the moment they left the view. In the instant, the hawk, as it was, joined the the sudden contrast, perhaps even resembling it with my pleasure in it that he, dashed speed for the chase.

tion of interest. That was enough, however. The work-packer gained a good yard and was safe behind the new bridge in a building. Five or six moments the location of a crowd is a relatively long time; and even the first death tolls, a fairly sudden personal matter. A double story, however, but that is another matter. This bird incident goes to show the difference between life and death, that some momentary diversion may make, such as a sudden noise, or some unexpected action that puts an alternative or a psychological disadvantage for some one instant.

Among birds is a type of behavior to avoid which I might say have a counterpart in birds. If you have ever tried to catch a bird in your hand, you will know that the usual result is that he is caught, and you are lucky if you manage to catch his tail. The double story matters when the bird runs. But the successful capture has not so much work done since the end of the tail when, by a quick turn, he can snap the head and the tail together detached instantly. While this moment remains struggling in your grasp to create a diversion, the rest of the bird runs off, and is therefore a new, though usually less handsome tail. I recall a ground lizard in field that when approached would walk slowly away with the light orange tail over its shoulder, as if holding a tail, in case of sudden pursuit. Then in the case of a bird jumped by an enemy, the tail is up to the throat and part, and the consequent might be noted by the person, and pulled out, allowing the bird to escape. This perhaps accounts for some of the permanently tailless individuals and sometimes seen. Again, a sudden spring and shooting of a black-and-white tail might have a more momentary startling effect, and make the relative difference between life and death. But even in the case with a

many birds that have conspicuous white feathers in the tail, as juncos, Tree Sparrows, and others. It is equally probable that such a use is likely to be altogether incidental and that such markings are really present from some very different cause. The authors cannot make up the thinking of white markings may often be helpful in detecting or avoiding a predator. We have seen how the experience of mistaking a Nighthawk as a Whippoorwill by day in the woods, and being astonished at his instantaneous disappearance when the conspicuous white patches on wings or tail were hidden as the bird alighted.

Still, we must well have in mind that such devices, while perhaps in slight degree helpful, are not in their nature concealing. For in most cases a marking which really is conspicuous. Thayer has suggested, however, that this may be masked by other patterns as in the case of the more familiar instance I am thinking of is that of our common striped snakes. If you have ever tried to catch one by stepping on it as it slipped off through the grass, you will realize that the matter is less simple than appears. The longitudinal stripes, so conspicuous on the back, run in the same direction as the snake's motion, so that when only part of the snake is seen it seems as if going much more slowly than it actually does move. In so the eye the same when the snake is extended until the tip of the tail comes in sight, though meanwhile the head end may be already a short way. It is possible that longitudinal stripes among ground-slinging birds has a similar effect, and that their movements on the ground could proper circumstances are less conspicuous for this reason. The opposite effect would be produced by cross-striping, such as is so commonly seen in cat tails and

many species of pheasants. These birds are distinct beauties. A rapidly moving tail of this pattern would give the eye the impression of a faster motion than reality, an account of the rapid extension of light and darkness in it that enough, a blur would result. Imagine the same slow extensions of Brewer's Phasianus running through the jungle before a watching wildcat. The motion of the tail would be so conspicuous that the cat might easily be confused as to the rate of speed, it act as to the actual whereabouts of the body body. Moreover, it is interesting to me that in pheasants both these types of coloring are combined, the body of one longitudinally streaked, the tail cross-banded. These days we may know more about the true meaning of these things, but they afford suggestions as far back as mind as we observe birds in their natural haunts. A single device may be put in several distinct uses, and perhaps only rarely or accidentally shown to be of value in helping to escape. But this day shows you upon the difference between life and death, for after all the most delicate things count.

But the tail is, among other features of many species, one markings as well as of bright coloration in general may perhaps be a display. For in a great many birds the male is colored differently from the female and more boldly, and goes through display action before his intended mate at the beginning of the breeding period and afterwards. In these times ornamented feathers or tails are erected or handsome plumage turned to best advantage before the female, and it is not unusual to suppose that she is in some way affected by this, and that her share of a mate may be put in question by the effectiveness of the show. The tails of some herons of the *Ardea*, which usually

are concealed under the wing, are at the breeding season thrust in view during the bird's display. The common stone pigeon, standing before his mate, turns around and around with lowered head, allowing the play of light to bring out the brilliancy of his neck-feathers. In many species the male is very notably different from the female at any season, as in the house-sparrow, house-sparrow, Chantrelle, and others, though even in those there may be slight colour differences at some or several seasons. In the first autumnal or juvenile plumage there is commonly very little difference between the two sexes, but in some species the two sexes belong to different sexes or males and females. Thus the Chestnut-sided Warbler in its autumnal plumage of the first season is generally above, with white wings, and usually white below in both sexes. The following season belongs the Chestnut-sided Warbler white wings, and white markings, in which the male is brighter than the female. In the Black-throated Blue Warbler the ground is lowered, and varied further. For the male with his black throat and blue-grey back does not pass through a stage in which he resembles the female in her olive-green dress with black throat. This stage seems to have been dropped entirely. Why this difference? In the more brilliant plumage is his display before the female, and is then not useful until the breeding stage of the first spring, why should the Black-throated Blue Warbler remain in white still in the "brilliant" stage of the first summer? What has the stage resembling the female's been dropped out? It does not answer the question or tell that it is a case of sexual selection, but it may be an illustration of what Darwin has called "monotony" in selection; that is, once it starts in males along a certain line of development it may

emotions in response to various stimuli, quite regardless of sexed. The classic case of this is found in an infant face of masculine, which in earlier periods was androgynous like; then later the forehead and nose straighten out, and finally in a still later period pushed around so that it goes against the cheek portion. This seemed to be quite possible one kind of spontaneous—and the face died out. The Black-skinned face's own way evolved so as to vary in responding that the difference of color between the two sexes is a result of the male's propensity for display of his plumage up before the female, and less desire of the more brilliant colors. But this is no doubt one of the factors, and recalled by Darwin (the last experiment) the principle of sexual selection. It makes sense or less evident, at first glance that this has been a point made, but there several differences of color, but it may prove to be only a guiding influence on sexual growth tendencies which had a sort of inevitability; perhaps in the chemical and physical processes of the body and all other means we are still very ignorant.

A remarkable reversal of the principle that the male is the brighter-colored, is seen in the familiar case of the pheasant, and in less familiar cases of certain of the ducks, in which the male is the darker plumaged. In these birds it is the male that is courted by the female, and he is in this consideration the darker of coloration, showing that birds have anticipated by many thousands of years a sex which suggested to be found among varieties of the same population of our own kind—an illustration perhaps of "parallel evolution"? This reversed relation of the sexes in coloring, wherein the female seems to do the active courting, is taken to indicate that her bright plumage has been developed in response to sexual selection; that is,

the brightest and most beautiful females would be selected as mates by the males. This certainly appears to be a reasonable inference, but may not be the correct explanation.

Now does it mean that the darker color of the female in offspring is due to her father has less conspicuous white in offspring, too, although this might seem strange, it is frequently the case that the brightest-colored male mates in this way. Thus it is not rare to see the brilliantly marked male House-wren (Svenska) during the incubation of the eggs, and Edward Kennard has described the like habit of the male Cuckoo. Yet it does not appear that the male bird is at a disadvantage. Indeed, the female can show towards the difficulty of seeing the male Cuckoo as it sits close on the eggs, despite its usually conspicuous black and white plumage. From these and many other like cases, it is not difficult to infer that among certain species this habit of the male in showing the incubation might become more and more developed, and result in his performing the entire incubation, quite apart from the parent of male when low-through display. It would be interesting to study male birds which sing, or species in which this habit is specially developed to determine exactly what value the male does take in the process, and to see whether or not different individuals or different species do not show variable degrees of parental assistance. This can be done accurately by the study of birds individualized by banding.

Finally, we must not lose sight of the possibility that the brightest or more conspicuous coloring of the male may spell protection and survival for his darker-colored mate and her brood, simply because his very conspicuousness makes him more often the object of pursuit by their enemies. This is exemplified in almost any collection of bird skins in which

It will easily be found that the light-plumaged males are due in some of the duller females and young, showing perhaps the greater conspicuousness of the males. One can easily imagine that a blue-plumaged Hawk passing over a nesting colony of Redstarts or Yellowed Blackbirds would find the opposite more easily shown to the brighter males than to the females, so that a more conspicuous plumage of the male would really serve as a protection to the other members of the colony. Such an individual selection may seem unusual, but it is really not, for we have seen readily present birds who live in defiance of their nature as individuals for their young.

This very brief discussion will serve to give a slight indication of the really complex nature of the sexual and mate of birds' colors, and may serve to suggest a few of the many possibilities that may develop them. There is a very great dependence here by these well studied observations of the nature of birds' colors as true facts, with a view to shedding light on these problems. But the observer in interpreting what he sees, must ever let us his guard lest he lose sight of alternative explanations, and especially lest he let his study in interpreting the motives of birds' motives be losing of human feelings and emotions. Huxington held that "this is the essence of all things," but a well-known biologist has warned us that this is likely to mislead himself when he puts his own meaning into Nature.

CHAPTER IV

BILLS, FEET, WINGS, AND TAILS

THE BIRD'S bill, as well as the feet, claws, and wings, are well as the beak and claws in many species. Its chief use is in capturing and grasping food, so that we find, among birds as a whole, an immense variety of shapes of bills, adapted for gathering various kinds of food. The simplest form is perhaps the ordinary stout, tapering bill found in sparrows, robins, warblers and thrushes, suited for pecking up small objects. But even among these birds there is great variety. The bills of shrikes for instance are somewhat elongated and pincer-like compared to those of larks, which are heavier and sharp-pointed, adapted for picking up, tearing open, or crushing seeds. The bills of Hawks are broad-based and hooked and provided with talon-like ridges at the base, the upper ridges on which their quarry pass. A further modification of the basic type of bill is that of the raptorial in which the tip of the lower bill has been altered so that it can strike out at long, so that they catch. The tip of the lower bill may curve to the right or to the left of the upper. This device serves as a wedge to give all kinds of pleasure. The raptorial bill is adapted for catching prey by the tip of the lower bill which can be brought closely together when the bill is opened slightly.

The bills of woodpeckers are adapted for being driven in and pulling apart the wood of decayed trunks and the



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generally suspended. The skull is large in proportion to the body and distinguished in color the crown of deep brown. Imagine how it would feel if our own muscles were extended a yard before our nose and the jaw is slighter still if we attempted to split our own legs wide apart! It is curious to find that the backbone, a group called the vertebræ, the two smaller vertebræ in skull would, but head largely in soft body which does not have to be extended from the trunk. Their bills are not at all distinctive but more nearly of the same, heavy tips, and with curved upper profiles.

Birds that seize their prey with the feet and use it as the side the bill, usually have a hook at the tip of the beak, as in hawks, eagles, and others. The double the sharp projection gives a better hold on a straight prey, and the pointing the beak is useful, since the prey that is being torn out. The same form of beak is found in robbers, grackles and others, which head by pulling the meat of food in place. Cormorants, too, have hooked bills. In all these groups the feet are probably but little used in holding the food.

It is interesting to find that hawks, which by some authorities are considered not directly related to cormorants, have a distinctly hooked beak in the culmen. This same straight and in young stages, however, to have the long straight dagger-like bill of the adult. When known head by quick take as much living prey, than fish and frogs as birds and mammals. For this method a long neck and a long bill are an advantage, giving additional length of vision and reach after the escaping prey. The same thing is seen in other unrelated groups, as in the falconing, terns, gulls, cormorants and others. The same principle is also

spread, too, by one swallow, but the former keep on their feet, then subside, rising by the stern and then wing, while the dog or wolf gives up, pants and rushes forward, slip side by side, partly for this reason, at least, that are characteristic, dogs (especially). Among the former there is too, the *Brindbill*, a peculiar function which is essentially the eye (black) round light. There, too, the bill is somewhat horizontal. It does not seem to be known that this is connected with its feeding habits.

Among the sandpipers and related birds there are a number of various modifications, for special ways of feeding. Many sandpipers have a simple, rather long bill for surface probing. In some this is very long as in the *Curlew* and *Curlew*, where it is perhaps correlated with their long legs and wading habits, permitting them to probe the mud while standing in several inches of water. An opposite case is that of *Wentworth* and *Jaegers* which have long bills but short legs. It is obvious that here, too, the bill, as a selective feeding habit, has done likewise and in places where they can walk well, on the surface, as in swamps, bays, bays and grassy meadows. The tip of the upper jaw in the *Wentworth* is further provided with a definite organ of touch and capable of slight movement so that in one spot where buried in mud and grass the bilious worms are found. Another unusual style of bill is seen in the *New Zealand Wren* (*Phalaropus*). In which one slip and turn off it, as might be the right. Such a modified structure is characteristic among birds, and it could not be an unusual again with peculiar feeding habits. According to one writer this bird follows around the legs of sheep, keeping in the right-hand side, but there seems to be few such observations on the habits. The bill of *Oxyechus*

with the flattened bones with its side as their edge, and one other end, it is still in pair of fingers clinging to the surface, but which they must by now well understand.

New Zealand is a place of strange birds. One species—the Haka (*Phormosus*), a black bird the size of a pigeon, with a curious red mouth and such other features—the several nests all having the bill of different shape in the two sexes. These birds, now believed to be exactly native following the distribution of the ferns, were said to come from the south—the pair always kept in close communication. They fed on a certain species of grub-bird, as dead wood. The tunnels of these grubs were dug open by the male with his straight sharp beak, and when it had laid bare the burrow the female, with her longer, more slender, and down-curving beak, worked in and extracted the grubs. In this way the two birds were said to work together, feeding on the common grub in a sort of co-operative kinship.

In the Laysan Islands of South America lay several closely related species of birds all placed in the genus *Phormosus* whose beaks in the different species have apparently all developed from a single prototype: some are longer and narrower, others shorter and broader. It would be thought that the long-billed birds would find no larger or harder work than required through the working, and that the short-billed species would not themselves be able. It detailed examinations of skulls and measurements of these birds, however, seemed to show that all lay on more or less the same level and no obvious distinction could be established between hardness of food and strength of beak. The case must be careful in making hasty conclusions. Nevertheless it is probably true that the large

Island species have a generally wider range of foods than those of mainland birds.

Another group of island birds among which we find the same types of bills associated with various feeding habits are the honeycreepers. The *Myiophobus* has a straight acrochordal bill for probing the crevices of flowers, but in South America we find those with longer bills, some slightly, others greatly curved; others still are slightly up-curved and apiculate, but feeding on particular species of flowers, certain of which are usually dependent for fertilization upon these birds, through the pollen transferred to the pistil of the flower and carried to the pistil of other flowers on the next feeder. In the West Indies I have often seen one of the species with a subtriangular bill (*Laniarius*) searching for small insects by moving quickly up and down along the under side of a large drooping leaf. They even come into houses and hunt the flies down over to the open air, greatly annoying small children. It seems likely that the downward curve of the bill makes most the gathering of small objects from a vertical or inclined surface. A very distinct shape is seen in the bills of some of the *Arremon* warblers, which are also flower-feeders. One in particular (*Arremonops*), yellow and black in color with subtriangular bill, I often saw feeding among yellow flowers whose corollas were similarly shaped. In all these groups of birds the special forms of bills are developed for feeding on certain foods, it seems reasonable to suppose that there are more or less dependent the life habits on which certain conditions the year round. Hence it is not surprising to find that many of these birds migrate with our great changes in their surroundings. Many birds in the Hawaiian Islands and in

From England, for example, birds become so specialized that nearly their entire lives were spent in particular species of trees or where flowers or other products grew. With the destruction of these by man the birds have gone.

The back of birds is covered with an outer bony shield called the scapularium. This usually appears as a single plate on each jaw, but is in the embryo of several plates which fuse more or less intimately as the bird develops. The scapula and alulae are these plates, usually more or less closely united, or else, as many are less solid, the back looks as if it were of several different plates. On the upper jaw there is a terminal plate forming the back of the bill, and back of this a longer one forming the ridge, extended into two bony ridges by which the scapulae are fixed to the skeleton at least one pair of plates which cover the sides and edges of the jaw. Each half of the upper jaw has a shield composed of an upper and a lower as well as an inner and plate. In Chickadees and the partridge-like *Turdus* group of North America there are, on each jaw, a plate on each side and one at the tip. Similar compound shields are found in the bills of several other groups of birds: as cormorants, some loons (as the Hairy Loon), and grebes, but in most birds is upper as all one plate. Edmonson, a Swedish zoologist, has recently shown I found that the different bony plates of such compound shields are homologous with the scales found in reptiles in front of the eye. Thus, the terminal plate of the upper jaw is equivalent to the frontal plate of a lizard, the one forming the ridge is equivalent to the lacrimal, these are each side correspond to the supratarsal labials, and that enclosing the snout represents the nasal plate. Similarly in the lower jaw, the terminal plate is the same as the mental or chin

place, while the one or two places on the side of the feet are comparable to the tubercles of a lizard. In the purple-winged Nighthawk, which we observed at New Zealand, it would seem that it is in the pure frontal rather than in front of the nostrils that the bar becomes heightened to form the long bill; due to this bird the nostrils are on the tip of the beak, and open on its inside surface. The lower extremity of the bill is often provided with numerous expansions and in the dove and pigeon has like expansions that serve in lifting and the minute web and several scales on which the birds feed. Curiously too, this same device with its height values is shed after the breeding season in the Pigeon and some of the crows. In the White Pigeon it develops a large tooth-like expansion toward the tip of the upper mandible like a parrot, and this too is distinctive the non-breeders, even when it is more abundant for display during the mating season.

It is clear from these facts that our senses rely not directly on the shape and structure of bills as indications of close relationship among birds, for they often assume several well specified forms that are similar in different groups or species where the same mechanical use is made of them.

Language.—There is a little bill always on higher of the size of the tongue. In the mammals the example and value which suffices while the bill they make, it is an entirely small, or that our readers it is in of any one instance. In most of our small birds, as sparrows, thrushes, warblers, it is thin and loose, slightly fleshy at the tip and with backwardly-directed spines along the sides. Such tongues are used in the handling of seeds or insects. In the White Ibis the large honey-sucking bill is



[illegible]

Italy comes about the hives and gardens here a honey-seeking tongue which is long, with a hook at end. Its sides are partly rolled inward, and by waving it into the long tube of a flower it can reach out the throat. In some of the Old World species, which are flower-feeders, and in those much resemble the honey-suckers, the rolling is carried still farther so that an actual tube is formed, through which honey can be sucked from deep flowers: the bending of the tip of these tongues also aids the flow of liquid by capillary attraction. The honeycreepers, like flower-feeders, have long and deeply forked tongues with a dilated flattened membrane at the edge of each fork. In feeding, the tongue is protruded and pushed quickly back and forth, rolling up the honey.

Woodpeckers have extraordinary tongues. In some species they are of great length, slender and jointed, with honey-buckets at the tip, but none at the base.¹ The tongue-bones or skulls that support the tongues are so long, that, instead of being attached at the back of the skull as in most birds, they run in certain woodpeckers forward as well over the top of the head and actually pass over the base, ending together at the tip, without sides and scarcely less the top of the head.² In other species the long ends cross and around the eyeball. This long tongue is obviously useful in reaching up into the cavities of living branches and eating out the hot grubs. As you might expect, the tongues of tapaculans are not so long, but are shorter, squarer, knobbed, but gathering up top (see *figure*, etc.).

Quite opposite to these are the fleshy tongues of shrikes and juncos, armed with a series of large hooks along their edges.

A particular of many birds is that, when the food is

swallowing the pellets is capable of much vomiting, and when about getting up food made as waste, they can rapidly bring whole crops, as this part is called, from the stomach to the outside, and then let it gradually pass into the first division of the stomach, or gizzard, where seeds are very thick and numerous, and are hence being hard and rough. Here the food is ground up, partly by aid of small sharp spindles which are used by many birds as a "first aid" or digestion. The swallowing of stones, however, is a habit occasionally found in birds that would seem to have little need of it. Pigeons commonly swallow pebbles, and these have been found interesting by American explorers, who would otherwise have taken of the nature of the rocks in the new houses or land where lost and were never so great an error. Apparently the House Lark had a similar habit; at all events, small white roundish pebbles of polished quartz were found in numbers among their selected houses on Peak Island, New Zealand. There may be mentioned the interesting fact that the crop of pigeons produces a substance called the "pigeon's milk," and it is found, on analysis, to be very much like milk in its nature.

The digestion of birds is very rapid, and this is perhaps due in part to the great length of their alimentary canal, as stated above for which it is greatly aided within the body. A minute study of the way in which this feeding takes place has been made up several recent investigations on one of Huxley might be shown clearly on the relationship of birds. There appear to be two principal ways in which this lengthening is effected: first, by having the intestine arranged in loops that are both end and first longitudes of the body; and second, by having certain portions of these loops return

into spiral coils. The first ring is the simplest and differs from the more complicated the number of longitudinal loops is usually four. These two series may be still further differentiated into at least eight different series of billings.

Birds' feet are as diverse as bills in size and shape. As we find out they generally show that they have and have correspond to the feet about size of the threatened bird. Usually the maximum in this size was lost in a stage before the bird-like condition was reached, for the earliest Everts called dinosaurs, some of which seem to have sprung from a stock related to the ancestors of birds, were also four-toed, as we know not only from their fossil remains but from their tracks still preserved in stone. In birds, the foot is made up of the distal and basal or tarsal metacarpals, the phalanges and unguites (toes or claws, quills, plumes). It consists of two joints in addition to the remainder of a normal joint of the long bones forming it, one where the ends of the bones meet. The three remaining metacarpals usually show three, and the phalanges respectively, so that by counting the number of these one can tell which toe is concerned. Usually the same formula for the toe joints is found in the long bones both of Everts. There are, however, a few exceptions among birds, for in certain old stone bones there were three joints each, and in guanothere the same was lost but instead of five. In some birds there are but three toes, as in the *Therapsid* *Woollyrhinos*, which have lost the intermediate toe—though there may sometimes be a minute vestige of it left. In other birds it is the equivalent of Everts one that has typical birds, but in some winged forms it is used as hind limb the first and the digits have turned back, the second and third turned forward. This is called a *reversed* or *prehensile*

condition, and in all our climbing. The web shows its intermediate condition, and can turn the foot too back or still. In the tropics (high-plumaged birds of the South American and African tropics) there are similarly two toes front and two toes back, but here it is the first and second that were front, while the third and fourth extend to back. Thus again, as is often among birds, a similar result is obtained in unrelated groups, but in a different way. The greatest retention of the foot is found in the ibis-like webbed toe, but not here, where corresponding to the original third and fourth. This is doubtless a result of the ransing habit, which makes using the weight of the body more or less upon one point—here the fourth toe—and is to be compared to the same thing in the webbed or claw, in which the ransing habit has caused the reduction of the supporting foot or two from the original three. In the foot, belonging to a group in which the digits are united in broad webbing, the final result is that it replaces the tip of a single toe, but so that two instead of one remain.

The toes are provided each with a claw, which may sometimes be absent as in some albatrosses, and in which a part may be present as in some of the albatrosses. The claws are long, strong, and provided in scale, scales, and bands that make their prey, but in some of the various, eating species there have been their sharpening, and are shown (and) hard. Another curious case of partial development in unrelated birds, is seen in the middle toe of herons and grebes-like (Nighthawks, Whippoorwill, etc.) which have the claw long and provided with fine comb-like teeth. It is supposed that this tooth is useful in chewing their food, but of this I have seen no careful account.

The web in many birds is strong, and useful in its use.



22. *Fregata acares* (Linn.), a small frigatebird, with a long, hooked beak, and a dark cap. (Linn.)

leg, as in Hens or some of our common fowls—For light feet as Chickadees. In the tropical regions, however, they are extremely long and slender, and are like members for giving support to the bird when about near blossoms and swamp vegetation.

While most land birds have the toes separate quite to the base, in others as the long-footed kind, there is a slight webbing between the bases of the three front toes. This is greatly developed in swimming birds, as loons, ducks, grebes, shingoes. The extreme condition is seen in pelicans and cormorants in which the web includes not only the three front toes but the small hind toe as well. Another method of obtaining a broad surface for swimming is seen in geese, phalaropes, and grebes in which the skin of the three front toes grows out in broad lobes that do not stretch across from tip to tip of the toe.

The skin of the feet and claws (usually in ducks) has scales, which may be short and firm. The entire surface may be overlaid by a single row, when it is spoken of as broad, or there may be many rows small scales like a newt-skin, a scaly-footed condition. The form of this scaling is often useful in classification.

We all remember the saying of Aesop in *Æsop's Fables*, when using the Fowls for a comparison, to find that they know best the wrong way backward instead of the right. This curious condition, I find, has puzzled other people as well. The mistake is that a bird's legs have bones hinged like our own, but the slightest (or [more]) is usually strong enough to be supported by the phalanges or ribs, when taken for the Fowls's legs is really the foot! The shock of a bird's foot (shown as the bones) really consists of three separate bones (metatarsals), the

the male breast bone, found here a single one, called a "median bone" from its long posterior shape. At its base and over the three original tips of these fused bones, as well as within the appropriate two joints. At the anterior end of this bone, where Adam supposed the bone was, there was originally a capsule and membrane, two rows of small white bones (the uracals). In birds the uracal was here actually fused with the alula bone (or ulna) and the other was with the clavic of the hum., so that the joint itself became three rows of bones more or less separate bones. It is called therefore a *trivincular joint*. In some birds there are still to be seen bones of the three bones of the foot that are now fused into the one alula. There is perhaps the three are partly separated by deep grooves, and in other species there is where a little hole or foramen lets between two of the bones for the passage of a uracal nerve.

In viewing our Christmas Turkey, we may recall that the drumstick is long and shaped like the calf of a leg, and that is what it really is, for it corresponds to the lower leg, or shin of mammals. The joint of the leg has really two bones, the tibia or male bone and the fibula, or much more slender bone on the outer side than bone to male. In birds the lower end of this bone has in many species disappeared, and the fibula is a more capricious at the upper part of the shin. It serves for the attachment of a strong muscle of the thigh as it might have been actually done every side in the human joints of quadrupeds. In some birds, and in the Pheasant, of domestic fowls, the fibula bone is, however, nearly complete and extends down to the foot.

The slightest or lesser is part of the delicate "second

plant" of the nose. The bone and gristle is considerably short, so gives more compactness and driving power for the muscles that ply the great valving, but also their lateral out-swinging, nose. The lower end always has double articulating surfaces: (i) the small under one fitting the head of the slender Bone, and (ii) the wide large one that fits against the skin.

It has most persons delight from the study of bones, so being considerably "dry," the matter is really one of the most interest and importance, not only in throwing light on derivations and relationships of the members, but also because bones (including teeth) are, with rare exceptions, the only parts preserved as fossils, and bones give almost the only clue to the nature of the animals that lived in the past times.

In general bone kinds are more or less similar, but an examination of the lateral boundaries shows many and significant points of difference on which we base relations, etc. The skull is perhaps the most important of the bony structures, for it is the seat of the brain and organs of sight, hearing, taste, and smell. The brain is the central receiving station for impressions from without as well as the dispatching office for impulses governing the relations of the animal to its surroundings.

If we take a skull of each of the four higher classes of backboneed animals representing mammals, birds, reptiles, and amphibians—say a cat, an ostrich, a lizard, and a frog—we noticeably different at once appears in the method by which the head is borne on the spinal column. In the frog and the cat it joins the column by two considerable bony structures, the basis and basals; there is but a single round bone. In mammals the lower jaw the bone is hollow

on the base of the skull on each side, whereas in the lizard it hangs upon a small separate movable bone called the quadrate. In birds the arrangement agrees with that in *Scaphiopus*; another important point of similarity. While not going into too great detail, it is worth noting a careful proposition that the skeleton of a bird is only a modification of that in the toad, or, in other words put in, a bird is merely a glorified toad. This point of view must be kept in mind when we later consider the subject of bird anatomy.

Thomas Huxley was one of the first to make a careful study of the different types of skulls in birds, pointing out their similarity to that of toads. The movable quadrate bone, on which the jaw is hinged, is capable of pointing the skullbone or jaw forward and thus can move the entire head. In such birds as parrots where it is united by a bar of bone to the rest of the skull. The same birds, however, the head is very little movable. Most of the separate bones of a bird's skull unite closely in early life instead of showing sutures or boundaries, but the bones of the nose and of the palate seem to show a number of relations with each other which Huxley used as a basis of general classification. The special bones are: (1) the beak bone lying in the middle of the skull just in front of the large socket whence the spinal cord issues, called the basipharynx. It projects forward in some species from being united in the rest of the skull called the cranium. There are two other median bones, one on each side, which are movable and extend in a V-shape from the quadrate bone on the angle of the jaw forward. These are called the wing-shaped or preopisth bones. In certain birds there are pairs of bones each side of the first lower jaw bone (the basipharynx) &



FIGURE 1. A. *Strophomena* (left) and *Strophomena* (right) showing the same structure.

FIGURE 1. A. *Strophomena* (left) and *Strophomena* (right) showing the same structure.

Strophomena (left) and *Strophomena* (right) showing the same structure.

after study

most prominent ending is a flat surface that bears against a similar curved surface of next protruded, giving side support to these movable bones. In the laminae, humeri, scapulae, and coracohumeri, collectively known as the *avian hinged-skeleton* or the *hinged-bones*—the condition is, generally, the same, and the hinged-bone itself is continued distally to abut against the osseous, which forms the center of the joint, and thus separates the two palmar bones, which are collectively much forming the sides of the web of the wing. This condition, since it occurs in the forearm, may be considered as another new isolated form, replacing osseous bone. It occurs rather characteristically of these carpal-like birds which in many other respects are exceptional, as for this reason Huxley called this type of joint "abnormal joint," meaning with just like the knee. Usually of the humeri and their bone, this condition of the joints is found among living birds only in the toothed shorebirds. Numerous, small quail-like species, which are peculiar in this respect, though related to the finches and sparrows. In this case the type of skull the lower jaw has but a single head the joint with the quadrate bone. There is all these points the skull of the carpal-like birds somewhat more that of reptiles it is regarded as more primitive than that of other living birds. In these other birds which of themselves of the lower part of the skull more that is, the paracarpal more the ends of the palmar bones, and all come together in the middle where the two central bones (the hinged-bone and osseous) meet. Moreover, the quadrate bone is the bone by which the jaw articulates with the skull; but a double head instead of a single one, and the little prominence of the hinged-bone which is the middle of the head against the paracarpal bones more or less act the present. This style of skull,

while especially the same in its general shape in the birds rather than the mammals and their two others in the details of the palatal arrangement, so that thereby make three large groups for the remaining species:

(1) *Orthognathous* or *orthognathic* birds in which the pointed beak runs from front back rather side by side on the roof of the mouth, so that there is a cleft down the middle.

(2) *Orthognathous* or *orthognathic* birds in which the bill is broad and the palato-maxillary is the middle.

(3) *Altrypognathous* or *opisthognathous*, the type characteristic of most species and particularly birds, in which the central bone of upper is broad, and the two pointed bones slender and not united.

All these types are perhaps rather different in their nature might imply and are useful only in the study of smaller groups, for different types of palate may occur in birds which in other ways are obviously related. This again emphasizes the fact that the different characters of birds are widely distributed here and there among them and we are not much to rely on as a test of relationship.

The study of birds differs very greatly from that of mammals. The work is almost all manual, studies of bones have been overlooked. In relation there are often found birds in which solid bones merely a few long ones in the longest species, while in the long-necked giraffe, the same bones have one each greatly lengthened to give the magnificent neck. In birds, however, the number is more constant; the long-necked crane for example has 23, goose 24, while the ducks with their well known neck usually have 25 or 26. *Phasianids* have as few as 22 to 23 and sometimes 24. This greater number of bones gives the neck more flexibility, and this is aided by the greater form of

the joint between the members which are usually somewhat mutually rounded on the sides is loose, allowing much lateral play.

In the lower part of the limb a number of the members become actually fused together and the bones of the legs (see picture) are usually firmly attached to them so that the lower limb is a nearly solid piece. This is necessary in order to give stiffness to the limb so that it may pivot on the legs, and particularly so that the bones forming the pelvis, which in reptiles and mammals may make a solid ring by the union of the lower or pelvic portions of each hip, is likewise unyielding except in a few of the fowling species. Thus the two pelvic bones, forming the lower of the pelvic region and normally not joined in most birds, is probably an adaptation to allow the passage of the large eggs, by springing apart laterally. These bones move therefore, as to some degree, instead of clamping as the ribs. See below. It is interesting to find, however, that in the Chicken, one of the more primitive birds although having feathers, the two pelvic bones of opposite sides are united by the middle, a condition probably of the original condition before reptile-like structure. *Phormiopteryx* condition has recently been made out, is the pelvis of the British Museum's specimen of that extraordinary and ancient land bird, the *Archaeopteryx*, in which the two pelvic bones come quite together below, but instead of being solidly fused, are merely in contact for a considerable distance at their tips, forming a T-shaped structure. This primitive bird will be referred to at greater length in a later chapter.

We are all familiar with the fact that reptiles such as most lizards, have long tails consisting of a series of joints,

and the same is true of most mammals. The joints of the neck and the scapular region are sometimes so short as to be unrecognizable. When these hindlimbs of the long tail be kindled in primitive bird-like conditions will be mentioned in connection with the *Archæopteryx*, but it will suffice here to say that the tail of birds, as far as the action of human eyes, has become very much shortened, and the line of length has been concentrated into the lengthening of the tail-feathers. In the familiar example of a human a glimmer before us, all that is left of the long lizard-like tail is the short out-crop and called the "goose's neck." This is found to have within it a few separate vertebrae, and it ends in a long thin-like bone like pygidial vertebra, if we were to trace back development in the embryo, we should find in representative number of joints of a once longer tail, that have gradually shortened until they have taken a single mass representing the large steering feathers.

The formation of a human tail is an important process. It is as different in the monkey-like birds, and their allies, from its condition in other living birds, than it forms pronounced point of departure in birdification. In the *Archæopteryx*, *Archæopteryx*, and *Archæopteryx*, it is a simple shield, shown on the lower side and around, arising in the embryo in separate halves that later have in the middle-line. The of the ribs in the thoracic joint the upper edge on each side. This simple human-like is very similar indeed to that seen in many birds, and probably represents an ancient condition which these simplifying birds have not developed. Besides all the embryo condition the view that the tail-like birds were probably never in the history of their evolution simplifying birds, and never developed their wing powers in any great extent. Hence it is reasonable to suppose that



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whole work hatched off from the main line of August 27, a very early time, and that there was nothing in the post-embryonic development as the last remnants of this branch. On account of their simple breviform, without heads, but much elongated, they have been placed in the group *Rafinesquina* or *Rafinesquina* with that as a subgenus, as opposed to the remainder of living species which have been called *Chesteria* or *Lepta*, with *Lepta* breviform, like a *Lepta*-type of *Lepta*. This division though applying to living species, is perhaps not a fundamental one for undoubtedly the two lines of descent eventually run together as we trace them back into the past. The fact of course arises because the very great morphological difference, in separate lines and gives them a firm foundation. Another fact very strong morphologically is the opposing morphological characters, as at the top of the shell.

Among these little white shells, the common *Fert* presents a breviform of parallel lines. When seen from above it shows, always, these parallel lines. There is first a very short space on each side near the front where the line is not visible. As compared with the same space in some shells in which at first on the side this edge, the distance is much shorter. As you move the line, from the front of the shell, a high wall is exposed, rising from a broad plate. This last projects the backward and gives an oblong surface for the two enormous muscles of flight as well as the pull the wing down as the downward stroke and on lower side shows ridges, passing over the shoulder, where it is on the up stroke. This last plate corresponds to the simple shield of the *Chesteria* in which, however, no head has been developed. The back edge of the shield ends in the *Chesteria* in a blunt point in the middle and a short pro-

position on each side. But in the chicken these projections have grown backward as far as the wrist-joint very long, as long indeed as the last of the breastbone. In the North American Tinamou, primitive poultry-like birds, these are enormously long, something as slender bones parallel with the long narrow keel. In the chicken other side-projections are developed on the front joints and at half-way points on the breastbone, so that when the bird is stretched out on its back its whole aspect is that of a narrow elongated bag.

Now in birds that are good fliers and have developed the lower members more than in the fowl, the space which between the keel and these narrow side pieces gradually becomes filled in with bones to give more solid attachment for the great muscles of the breast, and besides there is nothing left of the old wing as very shallow webs on the lower end of the breastbone, as even noticed if the present outgrowth is developed. The area above may be wholly filled in or as in geese and the duck either the web bridged across in part to leave a slender perforation. By this method of progressive development the breastbone of the more capitalised flying birds are formed, with their deep keel, long and solid sides, and ribs of long projecting ends, through whose articulation indicated by shallow notches where the ribs are not wholly filled in by bone. These steps can be seen very clearly in the development of the breastbone in waterfowl birds. The important point is that the secondary keel in birds of strong flight is merely a secondary outgrowth from the lower side of the breastbone to give attachment to the flight muscles as these have gradually become of large size and immensely broadened from the front of the chest to extend the whole lower part of the body.

The laminae is attached to the spine by a series of ribs, as it is sometimes. There are a number of interesting points about these ribs. In many species, especially in raptors, the ribs are numerous. Typically, as in raptors, there is a pair to each of the vertebrae or separate bones of the spine, from the head to the tail. But in some species that have given up crawling, the ribs of the neck shrink and disappear except those independent and rib-less attachments. These bones representing ribs are blood-veined, and in some birds these ribs or "ribs" of the neck ribs are perfectly identifiable as a more or less separate part. Of the ribs that attach the laminae to the spine, there are usually in the more specialized birds, including some small land-birds, only three pairs, with additional ones in front as behind that the next one is, though as shown by studies of the vertebrae, some of them do in these early stages, and probably some did in former geological times. This shows that this part of the laminae giving attachment to the ribs has become shortened or both ends in many species, while the level, as prominent a feature in flying birds, has grown back spine independently as a long process of bone for supporting the flight muscles.

A characteristic feature of birds' ribs is the presence of a little "cup" of bone on the upper side of the lower ribs, that overlaps the rib just behind, helping to give firmness to the body wall. This bowl-like piece is called the uncinate process, and among reptiles is found that in some species. It is absent in the South American *Thrinacosaurus* and in the various primitive fossil *Archaeopteryx*. In the birds it is sometimes but loosely attached and rarely comes very.

Two other important bones, the coracoid, humeral, somewhat rail-like pieces, spring out from the front of the

limbature, one on each side. The same bones are well developed in apilids, but in mammals are represented only by a little projection at the edge of the shoulder-blade.

In birds, they unite by strong cartilage to the shoulder-blade (as expected), and form at their point of union a kind of socket for the wing. The distal point of contact is that in primitive birds, as the familiar, this socket bone is short, placed in the upper corner by a small opening for the passage of a blood vessel, and the shoulder-blade from which it rises, but does not make an acute angle, such as seen in the birds with locked forelimbs. These bones are primitive, and serve to emphasize the avian character of the wing-like limbs.

The wing socket formed by these two bones is strengthened by the "scapular," or pectoral, which is simply the fusion of the two "collar-bones," and in birds of powerful flight is strong and helps to keep the shoulder-joint apart when the wings are raised. In some birds the two sides of this "scapular" no longer meet, but their lower ends are bound of tough cartilage.

We associate wings with birds but as naturally as we do with angels. A wingless bird is an anomaly, yet in the Great Lakes (and) of New England, the wings are so small that the more strongly symmetrical bodies follow the outline of the body. Hence this bird came to lose its wings or, completely, or was only gone. Presumably its wing-joint and ulnary bones lay on the dorsal and gradual line of these members; moreover, the bird is one of the *Struthio* birds that probably never were among birds. Yes, you will like the child, hearing the story of Jacob's dream, "If the angels had wings, why did they march up and down the river?" In the outline of the bird there are traces



SWALLOWING IN FLIGHT, WITH WINGS AND TAIL FEATHERS SPREAD, SHOWING THE
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of the distal end being and the usual three fingers of birds, but in the adult the distalities are usually lost and but two finger remain, proving that the wing was once better formed. In the young, as sometimes here of *Agelaius*, the fingers of the wing have an interesting but only one, the normal, is lost, and this has three joints immediately above!

The wing of a bird corresponds to the fore limb of a bear or to an arm of man, as does within other instances pairs of wings as well as arms in their shape or position are strikingly similar in position. The uppermost bone (humerus) has a much shorter upper end than its forearm, having the usual ball-and-socket joint. It is usually hollow, and on the under side near the shoulder has a perforation (the pneumatic foramen) for the entrance of one of the veins. In birds that have the wings very rapidly in flight, the humerus is very short, stout, and powerful, as in hummingbirds, swallows, and swifts, while in birds of soaring flight that do not flap rapidly, the humerus is long and well feathered to give additional supporting surface. No hawk puts it, if the long wing of the albatross should be moved as rapidly as that of a hummingbird, it would surely break. The forearm has the usual two bones—radius and ulna—the latter forming the outer and inner side of the arm, and bearing the secondary or smaller flight feathers. They are usually rather similar in most birds, but in the long-winged *Juncos*—birds of long and average in the long—the radius is enormously enlarged, bearing a deep-ridged blade in two parts (phalangoid) which once give strength but is lost in flying. For a number of birds other pneumatically with the arm is defined in attack, in the great and common. It

members of birds have developed spines, situated well in the middle of the bones of the hand, which serve as supports in flying. In the four-winged form of *Amblypterus* the spine is on one of the two wrist bones. Several of the phalanx bones show on the anterior side a long hollow corresponding to those forming the body of our hand.

A bird's hand is greatly reduced from the four-fingered condition of the lowest mammal. In all living and extinct birds, as far as known, there are not more than three of the four fingers left, though in the embryo *Charidia* traces of a fourth are evident at one stage but have disappeared. There has been some doubt as to which of the two fingers these three represent, but it seems most probable that the small bone corresponds to a thumb, the second to the index finger, bearing the mesopatagium, while the shorter outer one is the third of the original four fingers. This seems definitely settled by the recent studies of Huxley, who shows that one of the two outer bones corresponds to a fusion of the radius and its anconeus, while the other is the little metacarpal of the primitive hand. The first finger in birds is always small, and the long bones implanted at the two wrists are often joined together. In the reptiles these fingers bear such a close re-semblance to those of the birds that we are prepared to find that many birds still retain them at one or two of these digits as a reminder of their lizardlike ancestors.

The thumb has a well-developed claw in the low and second degree, and in some the young of that curious fossil American bird, the *Hesperornis*, which in early life resembles almost exactly in the hand, wing and foot birds. The claw may disappear in later life. In the *New World* vulture the tip of the long second finger often bears a minute claw, and we show that of gannets and some of swallows.

This is also hard to find among the feathers, for it is minute, as if the tip of the beak were protruding from the skin in any one place or not. The double nostril birds had well-developed claws and used claws to advantage in scrambling about among branches. This feature will be mentioned again in describing bird reactions.

Streamers.—In many birds the throat, instead of being filled with feathers, has hollows or wide empty spaces, so that they appear open to the eye. These apparently empty spaces are filled more or less completely by extensions of the branching system called streamers. The number and extent of these vary much in different birds and species, as in this one are equally diverse. They are connected with the windpipe or trachea where this forked or, as I should like to have said, branched, the two-ways. It is a fact familiar to many sportsmen that a broken-winged bird is difficult to draw to the end of the broken wing is not advantageously used; the reason being, that one of the streamers runs into the large lung (chamber) of the upper arm and streamers into the lungs that map. A recent exhaustive study of streamers in the domestic pigeon has been made by Bryan Miller (1914), and even in his illustrations their general behavior. They form an extraordinarily complex system of tubes and are not quite symmetrical on both sides of the body. Air passing down the windpipe enters each of its two branches, and then before the lung is reached, a side passage off from each of these branches into the streamers of its proper side. The streamers therefore are not directly connected with the lungs, but open into each fork of the windpipe just before the lungs are reached. (Miller found there were five sets of these side air ducts on the body. (1) Three running as tubes along the neck to the

base of the skull, with corresponding lines the bases of the neck and between the mandibles. (1) the area between the shoulder or scapulars, and situated on each side and before the point where the wingtip forks (from this we can various smaller branches lying between the shoulder of the shoulder and an important one that enters the top of the humerus and an axilla and into the scapular fossa); (2) (3) there are two pairs of intermediate axillaries the forewing before the long-shoulder, and (4) larger of all, the pair of subscapular axillaries, which are in the shoulder and partly within the scapulars. They are very elastic and constantly change shape to accommodate themselves to movements of the humerus. They are not necessarily for the right humerus larger than the left as muscles of the stomach winging or each spine on the left side. The pair of (4) is not present in the Buteo or scapular fossa. The use of these axillaries is still not altogether settled. They were most highly developed in large flying birds as eagles, vultures, pelicans, albatrosses, where many of the bones are protected by them. They are present in some degree among reptiles as in the chelonians. Some have suggested they increased the buoyancy of the body in flight, but, in some, for example, the bones are not protected by them, and they are greatly developed in some birds, where have suggested that they serve to give support to the machinery of the bird's body by filling spaces between muscles or moving parts, and in doing filling or compressing on the muscle masses. Miller believes they are associated with the long neck, where there is a column of air as long as the wingtip as he showed each time fresh air enters the lungs, at that is taken up for this, these expansions of the breathing system allow a larger quantity of air to

enter the body. Finally, the most recent writer, Huxford [1925], makes a somewhat less accurate statement of the view that they are as regular like body-temperature, so that if overhauling takes place through sudden exercise the blood may more easily cool by contact with dense air currents, the birds cannot perceive as the mammals the relief from overheating. The doubt of these functions can be granted on two grounds at least.

First, very lately we have seen of the increasing pains connected with the structure of birds, and particularly with the skeleton. The risk of a slight acquaintance with human physiology here in testing the anatomy of our present-day birds.

CHAPTER V

THE FOOD OF MAN

THE great activities of an animal may be thought of as three namely, self-preservation and reproduction, that is, the activities tending to do with the preservation of the individual and the perpetuation of the species. For the first of these, the prime need is food of the proper sort and in sufficient quantity. The food is the fuel whence is derived the energy needed to drive the body, and the food's food, as aptly put by Thomson, is like a high-powered engine, running at a temperature which its mechanism would be incapable of enduring. This energy, now only in the digestion of foods rapid and powerful, has their due in usually abundant quantities according to the food performance of each species, so that there is a comparatively small amount of waste given off as excreta, even the fishy waste being more or less solid instead of liquid as with mammals. This high-powered engine therefore must be run by the simplest grade of fuel to develop the most power with the least waste. Man's food must, including any food of an animal nature, afford the most economical form of nourishment, while waste of all kinds with their stored energy, of solid or sandy matter must not be value. Vegetable matter of other sorts, as leaves or pulp is less nutritious, requiring greater amounts and longer periods of feeding to produce the equivalent energy.

Some scholars insist, from their knowledge of manures, a

justification for natural birds indeed, most of the living species require insects, fish, eggs, and various species of amphibians, small mammals, or even birds. For example, one of the South American Bushmasters (Reithropanthera) is specialized for living in trees and with its poisonous fangs killing as soon the small birds on which it subsists. The trogon-like species are usually dainty-looking and lovely birds, and the same is true to a certain degree of birds. The many species of natural birds collected by birds, and their methods of obtaining it, form one of the most interesting topics in ornithology.

Turning first to the water-birds, it is surprising what large numbers of them are strictly confined to a lake, river, The lakes, the garden, the prairie, the mountains, prairie, and forest ridges, most of the water, gulls, and some are in large numbers dependent on fish for a living. In many other groups, too, interesting habits are found, which perhaps in some cases are actually ancient habits preserved, while in others they are more likely instances of specializations. For example, the heron-like group is rather interesting in a general history because one anatomically related to herons, but the only familiar fish-eating species is the Osprey, which may therefore be thought of as an existing fish-eating bird, even common to the mountains of both groups. A few of the eagles are also fishers, as the Sea Eagle of the Old World, and the Fish Eagle of Africa, which are even Fish Eagle will often dive for a fish, though the practice is rare the Osprey. In thinking of the Osprey's habit in the situation of an ancient feeding-trait, it is interesting to recall that it is one of the few birds with swimming a complete mode in the lower leg. Its long leg, too, is reminiscent of the heron's. Old birds

In which the following table has been developed as a specialisation within its particular group, we may perhaps include the Kingfishers, diverse relatives of the pelicans, eiders, greiffins, most of which are waterfowl. Although the diverging habits of their anatomical structure is still retained by many Kingfishers, especially the smaller species, the following manner is widespread in the group from the day bright-colored ducks of Europe to the Great Kingfishers of Australia. The habit also crops out among the eiders, whose relationships are nearer to night jays and shrikes than one would at first suspect. The Harems and the Great Blue and White are known to catch herring just by night at Iceland where the fish rise to the surface for an entire hour of day while in other is a group of Fish-eaters that have become specially adapted for subsisting on this sort of food. Many of the ducks, especially the diving ducks, feed largely on this as does, while the Mergansers may be thought of as specialised ducks that have become so far adapted for subsisting on so have developed a long and narrow bill which approaches in shape the harpoon-like bill of the loon, grebe, or loon as a diving implement.

The methods employed by birds in catching fish are various and interesting. The loons like most fisherman make it a matter of skill and patience, standing quietly in shallow water until a fish is lured within striking distance of the long neck and bill. With the loons, grebes, many waterfowl, and the pelicans, the water surface of fish water water has perhaps been responsible for a certain similarity in the construction of the bill, which in these three mentioned groups is long, slender, and harpoon-like for catching and seizing. The storks are not originally

and for propulsion, and is used in these fish, but instead the powerful hindlegs with their shortness bent and long stiff divide the smaller pectorals. Still a third method of swimming is illustrated by the plungers, as the large halibut, toad, and garra. A species of movement observed in the Chinese toad also depends from the method used in the fish, and joins with the previous in plunging, but has been a longer period, as described by the H. C. Ichthyops. The lowering and plunging of the halibut and toad is a familiar sight to anglers along our coast. The halibut usually chooses a hidden perch from which to make his lifts or may lower himself till he has got to make use of his fins, while the toad with grounded light protrudes the water down as quickly as the open sea, with down-turned head, and upon spring a lift it suddenly strikes with outspread tail, turns and descends slowly down, gradually emerging with its feet. In reaching the sea, and in comparison with the general anatomy of their size. It is evident that they swim. With the larger and heavier plungers, such as the garra, a different method still is used. Having lowered a school of fish, the fish gather over it and keep up a constant head-down of the surface, with one plunging in for its fish, coming to the surface and rising with others into the school, and a sufficient number is placed from which to keep eating about a/like once more the school of plunging fish. There is thus a constant circulation of the fishing fish. (1) down the surface of the plunge to the water, (2) followed by the struggle to rise from the surface against the wind in the maximum height before (3) the return again to the plunging position. Meanwhile, too, the school of fish may have shifted its position so that there is a gradual drift of the

birds of birds when they fish. The value of these diving zones and grounds is indicative of schools, and this is often rather advantage of the fishermen. The conclusion, then, the birds may take advantage of the disturbance made by a smaller moving animal, as when is the West Indies a British (Lamar) followed in the lot of our summer the value to plunge when the flying fish, indeed, as it were, by the water. The whole the birds that pursue fish under water, as with these plunging birds there is a certain similarity in the shape of the birds among unrelated groups, that is the tern, the gannet, and the boobybird, the pointed bill, significantly increases in depth toward the base with it forms with the skull a profile-like head that these birds also share the share in striking the water.

A careful study of our various of diving ducks has recently been made in Canada, who points out that they feed largely on the bottom or depths, which are perhaps more or less characteristic in nature for different species. It follows that the fish taken by such birds are chiefly those that lie on the bottom or fish under or among stones and algae. The conclusion that we infer from their different ways of feeding the competition is reflected in a minimum between these groups of birds that the bottom water is shallow water for their prey, those that plunge but to near the surface the gannets and boobybirds, those that dive to the bottom but in the the diving ducks, and those that, like terns and boobies, pursue in the part or least in intermediate depths. From a great number of accurate observations, Brown has made out the diving ducks a very definite time-to-depth relation. The length of time under water increases regularly with the depth or that it is possible to make out with a few degrees of accuracy the



Black-crowned night-heron (*Nycticorax nycticorax*) perched on a dead branch.
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depth of the water by observing the time during which the bird is down. This was found to be directly the bottom in seconds, and for each additional fathom 100 seconds. This implies that in ordinary dives of over 5 fms. a bird spends the same length of time ascending the fath as the bottom whether the distance down be greater or less, and what is more remarkable the same relation seems to hold for porpoises, gulls, loons, and seals, as well as the diving ducks, a race of "Auks" (*Halimasturidae*) in which the same level groups of birds. Thus, because of a gull floating by diving along a number, the following average periods were noted over known measured depths:

at 100, 200, 300 fms. depth in fms.	average length in seconds.	at 100, 200, 300 fms. depth in fms.
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The habit of diving has found its developed use only in the various mammals, but in the penguins, among the Yelkouans by the group of diving porpoises (*Phocaenidae*), in the seals by the *Cystis* (*Phoca*) and, strongly enough, in one group of *Phocaenidae* birds, namely the *Urolophidae* (*Phoca*), *Chirolophidae* birds that plunge bodily into aquatic streams and walk about floating at the bottom. All these, however, point out that the Count is an exception to the rule of 100, 200, 300, but the time-depth relation. In this respect, it may would determine the depth of water by finding the time elapsed while the bird is down, he must allow 100 seconds for the first fathom and then an increase for each succeeding fathom, as follows: The average for this is that whenever the water down equal to certain time at the bottom is ascending the Count, the Count, being a factor of water phase, merely shows a hundred of that

and as most remain white when in the water. The chief trouble is that an "immersion" has having modified what is many of the vegetable growths, being again in the water and, and it does.

There may be mentioned an interesting habit of some living kinds of swimming small animals, which are found in the in growing up the food. This is the case for example in guppies, and it is wonderful to learn from experience as the suggested elements that the fish's knowledge gained as to the geological nature of the conditions in certain places was derived from the fishes' experience from the demands of guppies without them. The latter had apparently had a thing for small aquatic pollution at all times in swimming for hours of this water lived in Black Island, Mts. C. Brown obtained among the lower members of these small polluted pollution which develops more after each stage.

From the human point of view the most interest in the fish and its kind is whether or not it is a source of supply the available supply of food fish. This matter has been been investigated for the species of fishes of the United States by the United States Biological Survey, with the result that examination of stomach contents shows to indicate that food fish is developed in any manner. Most of the species were not of fish or in water or in man, though at times the *Phrynosoma* (Cope) may cause some damage in fish production. This fact is well as other fishes, however, compares for any harm by destroying numbers of myriads which in the hands can keep themselves in shape. *Phrynosoma* (Cope) also food water, study on great water-bugs which are said to destroy fish fry. Townsend has recently published the results of an in-

responsible for the alleged damage done to the salmon fishery of the Gulf of St. Lawrence by commerson. From an examination of some 500 commerson he concluded that a well-filled one would weigh 1½ pounds and that twelve birds of this full size is the usual, not commerson, weight of the two-month class (May to September) average of 120 of this 1 species! This bird found in the commerson (taken from the dogfish's stomach, however, not salmon, but cod, plaice, herring, haddock, salmon, capelin, and cod. The salmon would be in danger only while so young. Evidently they descend on deep-sea waters in their second year: but one death return upon its death when an-grier they are of 1-2 lbs. weight and large enough to be safe from commerson. This evidence is that commerson affect the commerson fish more than salmon, in that to be devoured than otherwise, through capturing and then avoiding and the less active or less well-developed individuals. Therefore points out that in this and other cases in general, it need not be a matter for alarm that valuable species of fish are occasionally eaten. For with most species of fish, the number of fish is the greater than can be eaten and the surplus must necessarily be killed by some agent or other. The last known number of fish caught and actually a good one shows beyond the number that can be found there. This is, that has been established under present conditions of food supply and current factors, and the number need not give more the alarm if they do not increase abnormally. The last direct source from Schwenning Bird is brought out by Dr. H. C. Murphy who, in his account of the game industry of the Farallon Islands, considers the Farallon Cormorant "the most valuable bird in the world," not the world, but the the game district from the multitude of birds that

magazines are done dry and colorless—rarely better photos. This valuable facility is derived from the immense quantities of sandwiches which appear in these waters and from the distal end of the birds. The second reason is water pressure, and hence a great source of trouble for the photographer.

While being fed are given for many birds belonging to different groups—in gulls, gulls, ducks, and terns, and, besides, Kingbirds—about but are eaten by the sea. The large gulls, however, have developed the habit for this sort of food to such an extent that they seldom take living prey but have become chiefly scavengers, thus filling a niche otherwise not well filled by any of our common water-birds. The advantage of a scavenger's diet is that in many instances he does not, as when devoid of small living organisms, have the broad palate, and again that the prey may give him a large distal hole, it permits the scavenger to feed on falling spiders that if being it could not possibly master. In feeding the prey, too, there is an advantage in the gregarious habits in the sense that an abundance of food is more derived by the individuals within a small radius, though eating down around the prey drawing in toward it as much as it is digested by one of them.

The character of colonies of following birds must also have a certain relation to the movements of tide. For one example, of the various birds that might be used as sentinels there is one which only comes out when the tide is in the middle of the tide. For one only must show the water or the horizon from within, but their calls must be as such a point they young birds in wandering about their nests, as well as old birds "taking off" in flight, do not strike them in the water, but probably deep in the water. Moreover, they may

be obtained not less for themselves when taken together in abundance.

Altogether the relation of bioluminescence is of very great interest and importance.

In other forms of animal food available universally and in abundance, small numbers of many different kinds would not preponderate in the diet of many of the kinds and orders. Here many kinds of more numerous wild forms are utilized, and other less common, the discovery of which are welcomed among our beneficial species, though in nature they play their part no less effectively than those that help in reducing other species of mammals or birds either by direct or beneficial to our interests. A recent investigation of the diet of the Australian Bush Chat has yielded some valuable results. These birds appear to possess regular diets, not by day or night and at such times regurgitate as a general rule the indigestible bones, fur, feathers, etc., of their night's meal. It was found that on an average two such pellets were thrown up each day by a single well-nourished probably as many as three or four. On the conservative basis of two a day, this would make 120 pellets in a year, so that less of the British Agricultural Department of Agriculture collected the contents of 400 pellets from beneath six wells most carefully and found that what a single bird's chat has one year night has. The result gave the following total of 1207 mice, 123 rats, 7 bats, 1 young rabbit, 29 sparrows, 27 starlings, 12 other birds, 2 small lizards, 154 frogs, 12 large night moths, 12 millipedes, and a few other insects, chiefly beetles. Probably the sparrows and starlings were taken from worms at night. The composition of the great value of such an investigation of nature and man in population seems to rest their and the

that is carefully guarded by law in South Australia, with a penalty in addition to a fine of £25 for each bird killed. Study birds have the California birds process brought to attention. Many birds about the countryside for their value as killers of rats that do great damage to fruit raising districts.

Among land birds, the most general source of animal food is that supplied by insects. There is the profession and wide variety of insects that birds of various species have become adapted for pursuing them in their several different modes of life. We are all familiar with the way in which birds of several groups have evolved special feeding habits in order to pursue insects of a given habit. For example, the warblers, sparrows and juncos, the meadow larks, the black and white throats, the blue jays, and the wood thrushes of North America. Another set of birds, including swallows, and such diverse types as the New Zealand birds and the American blackbirds, pursue the flies and of flying insects, another group of birds pursue the insects that frequent water and the aquatic insects, including swallows, many sparrows, kinglets, warblers, and yet other groups, as warblers, flycatchers, and yet other groups have been seen pursuing them in this way. Again, many ground-living insects are caught by birds that pursue this type of habits, as thrashers, blackbirds, juncos. Much has been written as to the economic value of birds as insect destroyers. They are an effective aid in helping to reduce the economic damage of insects that are pestiferous and which are useful to maintain the economic relations of these insects. For insects have important enemies not only in birds but in bacterial diseases which may be more favorable for insecticides, many others

may be millions; other losses specially adapted for grasping upon particular than upon one of most important perhaps, but these, too, may have secondary parasites which in turn kill off the (from our viewpoint) beneficial primary parasites. The balance part is,

"The first four birds clear your birds from a bird loss,
And little loss betwixt them, neither of infection."

Plagues, therefore, a bird race as human, is more desirous of it is species limited to what from a human standpoint, they are that is positively harmful, or (2) are that is beneficial either in killing the harmful insects or in some other way, as in the fertilization of useful plants.

In case of various methods of insect pests, as locusts and grasshoppers that destroy our crops, or mosquitoes that debilitate man, it is well provided that birds are effective in reducing their numbers. It is also recognized that other parasites insects as well as humans are numerous elsewhere, so that the control of newly imported insects pests such as flies and house-flies needs in New England to be to be kept in check through the use of parasitoid "the natural killer" flies for birds. They come down to the popular explanation of various species. It must be borne in mind, as pointed out by Fitch and Wood and Chubb, that it is not to the advantage of any bird or parasite insect that it should actually exterminate the creature on which it feeds. There must be enough left to keep up the supply or the bird or parasite will exterminate itself, too. This we doubt, however with parasite insects to a large degree from time to time, though they increase as in the number that have species are few. Many birds, no doubt the same is true, but in some degree, but one insect-eating bird is seldom as specialized.

as to find exclusively on a single kind of food. In all this it is important to bear in mind that in the course of age the various conditions have been worked out whereby each successful species produces young sufficient not only to maintain an average representation but also to allow for a certain degree or smaller percentage of loss, as a factor of safety. If, therefore, birds are found on any one destroying, useful species of other organisms, this loss may be regarded as necessary or a certain extent, as it has been allowed for in the natural selection of the species. If it proves that the loss is not compensated, the species is not successful and tends help in the way of selection of species.

It would take too long to enumerate the birds of the water and as food by birds, but their relations to the water, spread and abundant use and services (as recalled other work) are especially interesting. These birds, especially water in the warmer countries and are commonly used and using the sea through. In the temperate climates they are active and abundant in the warmer months. These water birds render them in the tropics as abundant and always available means of food, so that it is not surprising to find animals of different groups specially fitted for preying upon them, such as cormorants of various kinds, various voracious mammals, various kinds of reptiles and amphibians, as well as a number of birds that feed chiefly or wholly upon them. A summary lately published by Huxford shows that only about very few birds prey the diet of many kinds of woodpeckers is built the fish and New World. Of our familiar species the Pilchard Woodpecker is especially fond of the giant black mullet which often grows to over four or five feet and runs in schools

far up within the trunk, using not the lower trunk. Such a case may appear perfectly usual externally but given to be studied on the very act of filling. It is no reason that wood-boring ants that the Pilosell Woodpecker uses the insect-like habit in the trunk of living trees, and I have seen a fine little yellow body cut through the trunk of a large tree. This common Flicker is probably the greatest consumer of ants among the eastern woodpeckers, and is frequently to be seen on the ground gathering them. It is remarkable that the salivary glands of the Flicker are unusually large, and I have had occasion to notice their great development among certain ant-eating mammals as well. Thus the secretion of these glands is alkaline, it has occurred to me that their general development in these cases may be in order that the food and which the ants consume is quickly killed by more or less neutralized.

Many tropical birds feed largely on ants, including the family of the Tyrannidae (Formicivoridae). There are others that follow colonies of driver ants and prey upon them. Many species of vultures are fond of winged ants, and at the same time provide great toll in value of them to many other birds. I have seen many Hairy Woodpeckers and Long-billed Woodpeckers chasing and picking them in mid-air during a September afternoon when millions of the insects were winging. No doubt it was they on the whole that was just then the great number of the day was taken with those that had followed the water and the yellow were busy picking them up. No doubt the insects could come in places not to the bird, and the same perhaps is accountable for the liking of some species for bees or wasps. I recall seeing a Clarke's Phalarope, one common wintering in Utah, picking beside a nest of hornets (Vespaula) picking off

and swallowing one of the insects. The movements and air flow as [around] the long tongue while she does this, that the inmates were thoroughly amused, and laughed heartily about the intruder, but the Karamahs are solemn, picking off what is needed occasionally's snuggles at one of the angry birds as shaking its head over and then as if something were uncomfortable. When an eagle swooping over I can imagine how humans would make a hot breakfast, and certainly the bird seemed to enjoy the sensation. In Africa, we had a group of birds, the Honey Chats, almost relatives of the cuckoos, that have developed a great taste for the seeds of wild hore which abound in some parts of the continent. The adults with their young here, and the young seem to be usually more or less inaccessible to the birds, but the latter have the remarkable trait of entering the situation of a native by a positive feeling or desire, and will lead him by a hundred of his fellows the bird. The African natives all have a great tooth and eye quick to make out the face and nature the honey, being able to know a portion of the seeds for the bird. This I have myself seen done, though the bird had not but no leading. Indeed, humans are frequently visited by the Honey Chats, people for the purpose of pecking on the face. In his rec. [?] of a South African species that he remarks that they with the long legs of hore, that had been living all that the pollen basket carried on their. It is also related that the adult bird does not discriminate between wild and "tame" hore and may lead one to a bush or a person's yard as well as to one in the house.

Leading now a consideration of animal food, we may again briefly the vegetable food of birds. This consists chiefly in (1) the direct vegetable material found in the

seeds of various plants, or (2) it may be the sub-pulp of the fruit or less often (3) the hard stone itself. It is natural that the seeds of plants should be more and more they contain the more concentrated nutriment. This involves a saving upon all the seed and nutrition of the bird, as we see so clearly illustrated for example by means of the flake. The grinding up of the seed of the quail is accompanied almost to waste with the addition of a nutriment of grit picked up with the food. The largely less satisfactory form adopted by the flicker-like birds that is a harder almost intractable of them, though found as well among other groups. An advantage of it is that it enables many birds to survive the winter drought of the more parts even and so it comes common wherever many of these species of the necessity of migration. Indigestion may therefore be an adaptation for surviving the winter of northern winter when about 75% in the stage of insects is largely reduced. It is notable that most migrating birds take insects as well, and further that their newly hatched young are fed on insects until they are sufficiently grown to shiver on seeds. That is, the weakness remains in its early stages sufficient to survive on several foods. This process of adaptation is perhaps illustrated by such birds as the Purple Finch, a member of a typically insect-eating group, that seems to live in winter partly upon bark-beetles (Curculionidae) which feeding is probably extensive, but these unsifted birds cannot stand upon the seed itself. By being largely on these berries, the Purple Finch is able to spend the winter more or less regularly in the north occasionally on southern birds, and so becomes an exception to the rule that our warblers all migrate to some distance in winter. A similar case is the White-throated

hardness may be partly responsible for the early arrival and less easy take-up, moisture is, which is different from any other species. The greater hardness with their powerful beaks afford an example of a group of tropical birds that live on mud-like food in large pools. In these birds we may imagine that they become saturated first through the feeding adopted, but passing the soft but thin pulp which covers the small birds of so many pools. This pulp they ingest eat and our might imagine it would be only a step from this to the making of small eggs and smaller pools made on shore of the shore from on which some of the smaller species feed.

Fishes (birds) are related by many birds and undoubtedly afford more or less nutritious eggs, water, and water. This seems more of a waterlike diet, however, indulged in partly as a seasonal luxury but when water plunders the surrounding food and partly when water food is scarce, as when it is when the water is the principal source of the food there.

Other birds showing the transition from the more primitive-like of animal food to the different or adaptive diet of vegetable matter are the ducks and their allies. They young ducks feed largely on animal matters, as water insects, and the same is true of the summer food of many of the Anatidae as the ducks. The sea ducks or diving ducks (*Phalacrocoracidae*) also feed largely upon animal matter, fish, mollusks but in autumn some species may become chiefly vegetable feeders, such as *Querquedula* and *Redhead*. Others, however, as the *Wentworth* and *Wentworth* that winter on salt water, continue their diet of animal food. This is a matter of much importance to the species, for those living on a diet of water plants could suffer on ponds of water

needed become sufficiently thinned for the birds, while those feeding on an animal diet are more ready to get practically inappetent to any but a stout stomach. The young go a step further and become largely gregarious in habits.

Again, among the gregarious birds including our domestic fowls, as well as the water quails and geese, we find species whose young probably feed chiefly or first on animal food, while the adults select in summer on foods animal and vegetable (piscivores). In autumn and winter as herons become fatter and the herons chiefly on almost wholly vegetable. Geese eat berries, buds, and leaves. I have seen the Egyptian Goose with its crop stuffed with its seedling in fall, and its well-known habit of eating buds has given the Red-bellied Goose a bad name in some localities where crops and buds have been so persistently ruined.

It will be seen that with some birds that have adapted to a vegetarian diet, there is still a return to the more primitive custom of taking animal food during the early stages, as in some species insects and occasional other animals are added to a diet chiefly vegetarian. The become chiefly vegetarian is similar apparently now, but among the pigeons seems more easily reversed. With these really omnivorous birds, the young one at first will feed on food of an animal origin, though strongly enough it is not flesh-sought, but consists of the so-called "pigeon's milk," a substance thick derived from the breaking down of the lining walls of the crop. These pigeons seem to be entirely unacquainted with the need of catching animal prey.

Of special kinds to which birds have become adapted, much might be said. Albatrosses, for example, feed partly or even by night, and this becomes explicit when we learn that they are rapacious, for squid are likely

in the water at the surface by night than in daytime. The same is true, too, in some degree of many species of small aquatic waders frequenting the glaucous of the sea. This may in part explain the nocturnal feeding habits of many piscivores. The birds that in Canada is often a phalarope, but rather than a fisher, and *Scolopax* divers of the bay that feeding when other almost animals are scarce the surface. In times of rough weather this feeding life seeks deeper levels, so that the English oystercatcher have explained the nocturnal great divers that overtake the Little Plover, following hundreds of these almost with empty stomachs, so that it is sometimes said of food another feeding in the temporary disappearance of the phalarope, and so depicting the birds of food and strength to stand against the darkness.

Another special food is that for which the African Tropic birds have become adapted. These birds feed with green hills covered with succulent or large succulents, growing close on their bodies to pick off the bits which abound in tropical countries. The large heron in their time are relieved of these feeding succulents, besides picking by the waving grass, when the birds suddenly take alarm at the approach of danger. Remarkable, too, are the great Horned Eagle of tropical America, a special enemy of the duck, and the Philippine Monkey-eating Eagle.

A food used in the drinking habits of birds, which have and perhaps have reflexively studied. We have all noticed that birds and ourselves dip down a pen, raising their head between each dip as it is to the deep trough down their throat. The quite different manner in which pigeons drink in their bills and pump in the water into a hose



Red-tailed Tropicbird and Green-winged Tropicbird, recorded at the same time and place as the above.

(Continued on "Tropical" page 100)

small have escaped the attention of most. We do not know much as to the habits of water birds and how often they drink. It is said that porpoises in small streams are able to lower springs by sucking the flukes of reeds or papyrus which must drink daily and by so draw the surrounding water regularly for the purpose.

Most birds do not know to drink and water is preferable to food; indeed caprine gulls may die without it. Land birds, however, need fresh water. No birds seem to me to get long periods without drinking, as is the case of certain birds that incubate continuously, for example the female Blackbird that is walked up in her nest every day and fed by her mate. In the far north water may be inaccessible throughout winter, but it may be possible for northern birds to reduce its want. I have known three Golden-crowns and one-headed a flock of Clark's Waxwings engaged in catching snow-birds during a storm, flying up and snapping at them as if they were insects. There is a silly old story that birds will not drink water from a silver

CHAPTER VI

SEVENTH AND EIGHTH CENTURIES AD

In previous chapters we have seen that there are many points of contact in whole birds, scapulae, scapulae, scapulae, scapulae, in the structure of the skull, the nose, the supporting portions of the braincase, the occasional presence of clear ridges on the flange of the head (as usually in the supporting habits, and in other cases). It is to be noted that through scapulae, scapulae, scapulae, scapulae, and all the other scapulae, we may confidently expect to find some of these scapulae in the scapulae structure of our present-day birds, as represented by fossil remains, and eventually trace the new scapulae common source. Let us examine briefly the evidence available. But, first, a word as to fossils. When people are apt to think of a "fossil" as something old, very big, prehistoric, or of an individual apt before the time in which we are living. Indeed, we often speak of a person as an "old fossil" if he wears glasses and looks prehistoric and wise. Figuratively, the word means something "big up." But there is one other point to be made, for it is not to give some idea of the time when the scapulae lived whose remains have survived to this present, we must have a slight perception of past ages of the earth's history and the conditions under which it is possible for fragments of animals to be kept for long periods of years and still preserve their shape and appearance.



1. A black and white photograph of a dog, possibly a Labrador Retriever, lying down on a light-colored, textured surface. The dog's head is turned towards the right, and its body is angled away from the camera.
 2. A black and white photograph of a dog, possibly a Labrador Retriever, standing in a field of tall grass or reeds. The dog is facing the camera, and its body is partially obscured by the surrounding vegetation.

There is first one and is left lying on the ground, when usually becomes of it? Its most noticeable stage quickly sets in, leaves of berries and seeds then descend in soft grains or rollers and small leaves of grass form it to the end and what they are. The harder parts bleed in the weather and gradually disappear with leaving remains of the original structure. Sometimes by the same chance a bird descends in a quiet pool, sticks to the bottom, and by another rare chance becomes covered with mud before the next water reaches it. If by strange combinations of circumstances it remains buried, and the mud gradually settles over it and finally eventually into sticks or mud-stones, the harder parts of the skeleton or even impressions of feathers may be preserved.

In such rivers and more, particularly in European regions, bones are often preserved from going to pieces by the washing away of sediments and gradual accumulation of soft mud, stones, rollers, etc. (which protect and mineralize). In this way bones of small creatures, brought together by such are often preserved. In California, there are wells of rocky uplands where surface, cold water and warm animals to drink. They become mixed in this natural trap and sink down to become eventually stored upland, perhaps in holes or good hiding places, large animals in the same way. Another method by which perhaps the more hard bones of birds have been preserved of one of the Oregon lakes is the relatively recent past, was accomplished a few years ago by the death of many water birds on some of the salt lakes of Utah and elsewhere. Unusual drought or drying away of water seems to have caused the alkali of these bitter waters, so that they poison birds which drink them but also drink or swallow

and the waters that the birds are actually turned into lakes of soup, in part at least, and are, when subsequently evaporation, they become covered with mud and are ultimately buried before they can rise. There are a few of the ways in which birds' bones may be kept from destruction and gradually turned up-stored by the slow dissolving of the bones and their replacement by mineral matter. The chance of a bone being preserved is exceedingly small, and the chance of its being found again even after a thousand years is infinitely smaller still. Suppose that all we knew of the present bird-life of the globe were a specimen, or bone, and an ostrich, is it obvious what a poor idea we could gather of the various species of living birds. Yet our knowledge of fossil birds is proportionately but little better.

Turning aside from all our previous ideas of age and time, let us take a glance at the past history of the earth as it relates to birds. If we look at an old family Bible of our grandfathers' time, we shall find on the right-hand page the number of years that were considered to have elapsed since the beginning of the world. The calculation is simple, for it is based upon a genealogical table of Adam and his descendants and their respective longevity. By summing these and four dates together, and adding seven days for the creation of the world, the exact time is obtained—we have then four years and 7 days 4. r. But we now know that the seven days are not to be taken literally and the three no longer appear in our Bibles.

We have examined the structure of the globe and the *Stratæ* as made upon it, while the miners drill and mine they have at last determined that there is a certain depth

while minor pollen-receiving ones was seen, of those that can be rather definitely made out and their systematic value of them gives us a solid basis for estimation of the past.

The general processes are that, on splitting or warping of the continents, so that large areas are raised above sea-level. The result is that the animals on each spot are isolated and existing power as they exist, dwell on the now-rising disuplifted land since slowly existing there again. The final process is a leveling of land areas with a loss of features. A new elevation starts the whole process again, so that the surface of the earth is constantly being moved down and up and split apart. Small wonder then that few fossil remains in the shape of fossils should remain in so short the more ancient times! The animals moved there by streams and dropped as they made the level, if accumulated fast enough, were here and preserve remains of animals, and the posturing of the facts that found shows their succession in time. By making a vertical section of all these beds, we have all the different periods may be had. Various means of estimating their age have been employed the most ready manner of which is perhaps that in the brilliant work of Russell, who made use of the radioactive minerals and by determining the quantities of isotopes and had in stock of various strata estimated the age of them by measurements of the rate at which sodium, a radioactive metal, breaks down into these elements. In now we have a chronicle of part of the earth's history, in which some of the chief divisions are shown in the following scheme, and in which references will be made as we proceed.

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Population	Changes in Aspects of Feet	Feet Apr to October as End of Period	Important Bird Localities
I. <i>permanens</i> as <i>permanens</i> Nov.			
1st <i>permanens</i>	1-1.1		Bosnia to Iran, Cauc. Range, Himalayas, New Zealand.
II. <i>permanens</i> as <i>permanens</i> Nov.			
1st <i>permanens</i>	1-1.1	1-1	Caucasus, India, France, Siberia, (Caucasus) New Zealand.
2nd <i>permanens</i>	1-1.1	1-1	
3rd <i>permanens</i>	1-1	1-1	
4th <i>permanens</i>	1-1	1-1	
III. <i>permanens</i> as <i>permanens</i> Nov.			
1st <i>permanens</i>	1-1.1	1-1	Himalayas, Sib- eria, (Caucasus) New Zealand, New Zealand.
2nd <i>permanens</i>	1-1.1	1-1	
3rd <i>permanens</i>	1-1.1	1-1	
4th <i>permanens</i>	1-1	1-1	
IV. <i>permanens</i> as <i>permanens</i> Nov.			
1st <i>permanens</i>	1-1.1	1-1	Himalayas, Sib- eria, (Caucasus) New Zealand, New Zealand.
2nd <i>permanens</i>	1-1.1	1-1	
3rd <i>permanens</i>	1-1.1	1-1	
4th <i>permanens</i>	1-1	1-1	
V. <i>permanens</i> as <i>permanens</i> Nov.			

Compared with regular mammals, the mammals of birds are very rare and no amount of dark, fragile mammals and birds make them fragments of the stronger birds. It

It is natural that the more recent deposits should have more abundant bird remains than they have undergone less disturbance. In one case among the asphalt lakes at Barden in Iowa, California, have yielded the remains of a great many birds, and these are chiefly birds of prey and members of other water-birds. They date from the last ice (Pleistocene) period in the present day (but the Pleistocene is really but a continuation of the Pliocene?). The former were doubtless attracted by the animals entangled in the pitch, and include many species, among them a long-legged eagle of a kind no longer living, as well as a large hawk of a genus (*Circus*?) now confined to North America. Another closely related species of the latter genus has lately been discovered in other deposits of Miocene age in Nebraska, and is third in the still older Miocene beds in the same State, proving that these birds in the past lived over a wide range in North America, but were never only in the western continent. There are also two culivets similar to those of the Old World, and representing a different genus from ours.

A most extraordinary discovery in these same asphalt lakes of California is that of an enormous eagle-like bird, which has been named *Phaethon*. Its skull alone is twice the size of a Bald Eagle's and other bones are in proportion. It might at first have appeared a veritable colossal *Archiphetus* (Pachurus) Eagle but it has made out at least six species of various, or decussating birds from this locality, that really is a much larger than in the recent past that is present. The same is true of the mammals. For huge ground sloths, sabertoothed tigers, and giant weasels (all these bones have been and attended these birds. Evidently the gradual extinction of these large mammals was a con-

soft melodiously forth as a note below thrush's note and delicately sang the death song. The warlike bird at length appeared, and emerged upon him, but as it was in the act of leaving off its prey, was shot as death by a volley of arrows from the natives. "Who knows but this tradition may relate to one of the best of the Tropicbirds?"

Of other extinct birds at Hawaii the first is one closely similar to the Old World Peewee, perhaps an immigrant from Asia as a close race as very remote when a solid land connection existed where now is the chain of Hawaiian Islands, though more recent investigations seem to show it is a connecting form, near the United American Bristle-Throats.

The most famous of recently-extinct birds is probably the Monk (*Monia monia*), chased by the early navigators on the island of Midway near Midwaypoint. It was really an enormous pigeon which had lost the use of its wings. The first account of it is from the Monks who visited the island in 1791, and believing they had discovered a refuge for pirates, the natives were banished there for a time enjoying the delightful climate and feeding on turtles and Oysters. The birds were that a century thereafter the bird was quite exterminated with scarcely more than a few skeletons and early figures, as shown in following generations. A nearly related bird on the neighboring island of Kauai met a like fate, the Peewee. On Midway too was a large flightless rail.

Midway was the home of several species of Cuckoo-birds (*Coccyzus*), all of which were in large numbers when it was first so thoroughly peopled. Many of their enormous human bones have been found and even found eggs a short time. The largest species could not be less high,

with profound ignorance but small heart and depressed wings. In New Zealand, too, was a race of large birds now almost gone—the *Moa* (Dromaius), representing a really distinct type from the *Struthio*; also a flightless goose. The *Moa* lived till a very recent time and was probably killed out by the aborigines, but the bones and fossil in their *Struthio*-skulls.

Now here, then, the large birds are among the first to go with any deterioration of their great island life. It is a rule of evolution that the development of large size in a fixed stage is growth and indicates an adjustment or attitude over others of life that, if changed, will stand for the species. Hence "gigantism," as the French call it, is a dangerous thing.

In France, particularly in the Paris Basin, many bones of birds have been recovered from ancient deposits in strata were probably warm, and that birds, according to their well's evidence, nearly the million years to the early part of the Tertiary was an *Europe* time. From our deposits at Chaux we get species representing some 22 genera, have been identified among the bones found. These include cranes, a waterfowl allied to the *Anas* genus, a *Struthio*-like or long-legged eagle now confined to Africa, as well as waterfowl, herons, sandpipers, partridges, waders, and cranes. More interesting now are the remains of swallows, birds of brilliant plumage now confined to the tropics of America and with other species in Africa and Asia. There is another extinct species of swallows known from Miocene formations in France. The point of the bones reminds of the general form suggestive of a wide European range from the far New World.

Although the many remains of these early Tertiary birds

yet found) are that they must part of the same general type as birds of the present day, it is likely that, if we knew more about them than what we know from a few bones, we should find they were in many respects different from their present-day representatives.

We must mention especially in this connection that the living birds we are dealing with are the extinct *Archaeopteryx* (of a yet more ancient company), and that in the past we have some reason to suppose that particular habits that they did not long show with changed conditions. Moreover it is of the opinion that, as with mammals, some of the larger members groups were well marked as the beginning of the Tertiary era, though probably less so some of the greater and species were quite the same as their descendants. A recent and most important discovery of this early time is a nearly complete skeleton of a very large pterosaur, *Archaeopteryx*, which from its degree of completeness really is a landmark in our knowledge of ancient birds. It comes from the Lias of Württemberg and portions of a similar bird have been found in New Mexico. It was probably as large as an Ostrich, more than four high, heavy-bodied and with massive neck, enormous head, and very small wings. They sometimes find others many points of resemblance to the South American *Archaeopteryx*, a peculiar avian-like species. Very recently the impressions of long pharyngeal cartilages have been found in the scales of this age in Colorado, and are believed to represent in pharynx. Some of the primitive points are the imperfectly double joint of the jaw, the wide angle of the shoulder blade and pectoral bone, as in pterosaurs; the broadish and platy-like bones, and the fact that the pelvic bones exactly meet below the pelvis. The pelvis is of a more

modern form ("homogony") as mentioned, agreeing with that of so-called Cretaceous birds (Hesperornis). This somewhat special case indicates characters of both Eocene and Cretaceous birds, and indicates that the two types are not as independent as is generally developed from a common ancestral stock with more common. Let us then pass back to the even more remote period, the Cretaceous, belonging to the so-called Mesozoic Era.

Two birds are known from these ancient deposits, but these two are of special interest. In addition to many bones from the chalk deposits of England there have been found in the Cretaceous strata of Kansas considerable portions of the skeletons of two birds which, according to our authorities, lived over 100 million years ago. They represent two very distinct types, but also the first time we find birds had simple teeth beneath the beak as in birds do. Thus there is another step toward the reptilian ancestor. One of these extinct birds was rather gull-like in general shape, and its forelimbs had a prominent hook. The wing was well developed, with the three fingers as in modern birds. It is called Ichthyornis or Fishbird. The other was in general form probably like a large gull, with a long body and neck, long narrow bill, with the addition of teeth, and the same short thigh bone, long tibia, and an enormous hump for muscle attachment. It was certainly a wonderful creature, but was flightless. The forelimbs too are well known of the very small size of the wing. This is the Hesperornis or Storm-bird. Thus we see that birds in those early days had not yet lost their teeth. The saying, "Teeth in bird's beak," would have meant birds in Cretaceous times. We must realize, however, that even then there were these birds of today or specialized that



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they had lost the use of their wings, and that there are but two of the many kinds of birds that must have lived during the six million years of the Cretaceous period.

It is hardly possible now to inquire further back into the past. Not by use of the greatest imaginable pieces of luck, we have two skeletons from the Jurassic period, some 14 million years before the dawn of the Neogene. There is a bed of stones in Connecticut, America, of such extending size grade that they are made useful for purposes of lithography. This stone was probably laid down so long that it is still newer than even you. In the course of quarrying it was discovered that a bird had been found so beautifully preserved that the outlines of the feathers are still to be traced. This is the famous *Archaeopteryx*, or Dinosaur-like Bird, the oldest feathered creature yet discovered and cannot overestimate its age. For, while the birds without national are clearly birds in all their points, except perhaps in the preservation of teeth, *Archaeopteryx* is a real connecting link with the Dinosaurs. This Dinosaur-like bird was a bird bigger than a magpie, its bill was short and stout like, with 12 simple teeth in the upper and 8 near the tip of the lower jaw on each side, and its bones' structure. The structure was unlike those of modern birds in being entirely or supported at each end by numerous, it had but one neck vertebra, which is less than in any living bird and its vertebra therefore the Dinosaurs which usually have nine. The breastbone was apparently lacking, implying strong breast muscles, the ribs and blades of the "skirt" were not joined together, while the foot seems to have been much like that of modern perching birds. The bones of the palm have been found, by more recent study of one of the specimens, to extend below the palm, and although they

some closely against each other in the middle line, they are not fused. In this as well as in the reduced number of teeth in the lower as compared with the upper jaw, a higher stage in some respects than more modern conditions in which teeth disappear completely, and the gular bones no longer even touch below. But more remarkable in the bill, the smallest bony part of which is being, instead, of being jointed as in a hand and with joint bone, a pair of large brachia (just as with fish). In modern birds the bill has become so short that its bones hardly extend beyond the general outline of the body, and the mandible now instead of being immovable (as in birds like a *halcyon* like *pygæus*) while the tail-feathers, that in *Archæopteryx* grew out in pairs all the way down the long appendage, are now represented by several of the middle ones only, for the tip has no skeleton as in the modern ones.

The discovery is enough of itself to prove the existence of birds, but even did not this discovery help us to find the fossils that birds have started from. We know now that some of the dinosaurs are rather birdlike in appearance, and several of the smaller species are especially so. These together with a several species some walked on their hind legs, had three toes in front and one behind like birds, the lower jaw long and slender, and in walking ran. Held off from the ground, the formation of their pelvic bones was like that of birds, and they had long tails like *Archæopteryx*. Dinosaur eggs have lately been discovered, and were impressions of their skin, but they had no feathers and their fore limbs were so it was weak though like birds the hand had three fingers. Evidently, once they lived in the same time as *Archæopteryx* and *Amphioxus* etc, the late *Carboniferous* time, they could not have given rise to



Small, pointed, blackish-brown seed, *Archegonum*
longicaule (L.) M. (Rubiaceae)

Birds. The long legs, however, enables them to stand head of reptiles or unimpeded that they might easily have been the strategists where the small bird-like dinosaurs as well as long birds were absent, with slight changes. These creatures were evidently common and widespread, and have the explanation name of *Pseudomantis*, which in Greek signifies "imitation mantis." Some of the various groups of reptiles have been found in the Triassic formations 1 1/2 to 2 million years ago in localities as far apart as Connecticut, Sweden, and South Africa. Living in the period preceding that in which we find *Archaeopteryx*, they seem to supply the greatest stock of birds the bird-like dinosaurs and the four-toed birds. These "imitation mantises" have not yet gone too far on a line of special development to provide such mimicry. The first point could be derived from nature by making the lower or public foot further back. The long lower (metatarsal) of the foot were still provided as in dinosaurs, and it seems likely that their later species later a camouflage as in birds appeared, as Odum suggests, as an adaptation for strengthening the foot in walking or running on the two legs. But it is hard to see how a foot of this type could have evolved through climbing habits. The same point is strengthened among mammals, in which the running species have the reduced metatarsals through habit of their forefeet, whereas climbing mammals such as squirrels and monkeys have not. Brown (1913), who has made a special study of these "imitation mantises" concludes that a reptile of this type "which through a bipedal habit had developed a strengthened ankle-joint and a long metatarsus [or metatarsus], and had lost the little digit from the manus [hand]" would meet all the requirements of the creature

of birds. Their hypothetical ancestors, the which therefore there is abundant evidence from a study of comparative anatomy, are called by Huxley, an English zoologist, Perissurus, or intermediate forebears of birds. "We know that we may get almost the best notion of what the original point in their evolution was with the development of feathers from long overlapping scales. They were doubtless quick runners on the ground, and probably were quite used up their feet by pecking at insects. Their shoulder bones ended in three long fingers each with a claw, and they probably had some sort of wing for gliding in long leaps from branch to branch or tree to tree. They retained the sharp-pointed central tooth of the "injection moulds" but eventually lost them (as even *Archæopteryx* had begun to do) when the heavy beak developed. All the evidence points to the conclusion that the known birds were all evolved from a single line of reptile-like ancestors during a time of perhaps 150 million years of the past, and that though the structure developed from time to time in almost all various species habits, the group as a whole is clearly a natural monophyly; that is, all birds are descended from a single stock that lived in the remote past, and none of them has come from any second stock or replica of the same or another period.

Having thus briefly glanced at the birds of past times in an attempt to give the probable ancestry, let us, before leaving the subject, note that birds have means that even man is not able to do. They have the power of exchanging oxygen rapidly about as the chlorophyll of the leafy plants in forests. It is hard to conceive of as long a time. The mind there are comparatively in. Imagine a line 100 feet long, each foot representing a million years; construct a

point as this land, *Archaeopteryx* a point as the other. If we start working toward the common link, we shall find that by the time we have passed the days of Tauschia wood's preprogenitorhood, we shall have progressed a distance almost equal to the width of a thick pencil-line, or the thickness of a thin paper. After going back the vast space of a third of an inch we shall have passed the longest terrestrial time on the early lower days of life, and at the end of an inch we shall be well into Chasid times. The first hour of our epicurean journey will have brought us only to the beginning of the latest or Pleistocene epoch of earth's history, and we shall have accomplished long (and long the journey we are made the theme of the Poetic Books and the great Charybdis of Human days. And even when we at length reach the journey's end, we are still a long way from the starting-point of birds. Thus we may realize that geologically speaking a thousand years is not really such a very long time as it is only that our thoughts are small.

Immigration of birds.—It is clear from what has preceded, that the birdfauna of the globe has undergone very great changes during the course of time, not only in its nature but in its distribution as well. "Why, for example, do we find on the present day *Chalcophaps* in Africa, and their near relatives in South America, but none between these distant points? Why are *Colinus* and *Perdix* found regularly in the North Atlantic, and why are trogons confined to the tropics of both Old and New Worlds but absent elsewhere? There are like questions we have no answer to here of our almost entire lack of knowledge of the past distribution of these birds. When, however, we find that there are several Chalcid species in Asia, a small distance

in England, and small wrenns in France we may conclude that in former times the ranges of these birds were either more extensive or else very different from what they are now, or that there has been some whereby they have been able to colonize regions from which they are now absent. We need not in groups like this suppose that the arrangement of things has not been always the same as we now see it. We must look upon the present distribution of birds as the end result after many million years of slow or rapid change, not only of the earth's own land but of its ice boundaries as well, in their endeavor to adapt themselves, whether consciously or not, to the great variety of conditions.

There are, then, two chief factors governing the distribution of species at any given time: first, the historical factor, that is, time and chance; a particular race that has perished; and second, the adaptive factor, that is, what particular trait species have for successfulness in certain biotopes. To illustrate the Golden-crowned Kinglet is a bird found from western Europe and the British Isles right across the northern parts of Asia to eastern North America, showing finally on that whole geographic range can be suggested. It is probable that this very bird reached America from the eastern continent during a time when there was an extensive land connection from Europe across to Asia. Such a connection appears to have existed, perhaps only at intervals, during much of the Tertiary era, or its history is later Pleistocene times. Thus the historical fact of a continuous land area between what are now separate continents makes it possible, we still assume, for English to extend their range from Asia to America. The second or adaptive factor is that they have a perfect

less for the northern wingless birds rather than for open country or forests or single woods. For this reason, what having resulted this migration, we find them divided no less wingless birds. If the latter were not to be favored, not only in whatever numbers decreased, the wingless would doubtless perish too, not being able to flourish without their dense, open or habitus. It may be that a number of birds as well as mammals reached America from Asia in geologically recent times, and being, like the kinglets, members of the northern wingless birds, have not been able to range across the entire northern part of the continent. This explains why in common with northern Europe and Asia, we have a number of birds in North America that are characteristic of this group of birds. Such are the Three-toed Woodpeckers, Pine Grosbeaks, Canada Jays, House Wrens, Red-breasted Nuthatches, and Chickadees, all of which have done better in the Old World. Kinglets are among the birds of this group, but in North America have only extended part way across the western coast, probably because of their preference for the sort of habitus in which we see them in our Rocky Mountains.

Birds are very numerous in this low for certain localities and it is probable that the few migratory species, at least, are rather slow to colonize new regions even when opportunities arise. Of this, however, we are in a better position to judge as years go by and we see their steady wave of forms adapt themselves to changes brought about by man within a century or two. Thus the increase of grasslands in parts of the West through irrigation has caused a steady spreading of *Beldia* in range the new regions made available to them because of their adaptation to grasslandness in breeding places. The clearing of our

New England forests and the outskirts of both growth increased since a new through highway laid, but the Chestnut-sided Warbler, which once certainly occurs in places where a hundred percent might well be found. This illustrates again the changes being in distribution. Suppose now that the better places gradually gave up to flocks of red, purple, blue, etc., warblers, so that in general New England, other birds will come in where previously in the same area, as Greater Tanager, Cardinals, and Red-eyed Vireos. Following these come in gradually a few other pine or pine place, and with these come the Black-throated Green and Pine-cropping Warblers, Green, Blue-shinned Hawks. In short, there is found to be a regular succession of faunas characteristic of the different types of vegetation that naturally follow each other in the various stages of a forest from open country on clearing up to thick wood. These different sets of birds, mammals, or insects that go with certain kinds of vegetation are called associations, and exemplify the adaptive fauna in distribution. Hence the relation is so very close that a particular species of bird may spend much of its life in a certain sort of area. The Pine-cropping Warbler, for example, is so closely associated with pine place in the breeding season here, that it is seldom found far from them. The Black-throated Green Warbler is in general New England more frequently in other places in the same way, though farther north it disappears. Other instances readily occur.

There are some of the details of distribution. In a large area, and including many kinds of very wide or general distribution, our Florida American species that may go from pine to oak place, birds that breed chiefly in the north, and in a general way are limited in their distribution

range to the southern extension of the range and give latitude that runs through part of the continent and follows more along the higher elevations of the Alleghens, Rockies, and Sierra Nevada Mountains; second, birds that breed chiefly in the summer, southern parts of the continent and extend north to meet those of the first group. In the East where there are relatively few mountains and the land is less greatly varied in level, the separation of these two is less well marked; but in the western mountains with their increased altitude it is often very obvious that the southern mountainous species, the high birds, the southerners, the lower.

Altitude is in a general way the equivalent of latitude, that is, if one ascends a high mountain on the equator, he grows colder, warmer or colder climate, just as if he had gone all the way from the tropics to the arctic regions. It is found that in general every 100 feet of elevation is the equivalent of an additional degree of latitude. Thus it is that lower and Western Mountains worked as arctic regions on the mountain of the Appalachians and the nearby peaks, with a number of arctic plants, insects, and spiders, the equivalent of the Labrador coast, though there are not on the ground there any arctic birds that breed on these mountains.

Characteristic birds of the northern zone are: Pinnipeds, Redpolls, Gulls, and Murrelets; (Arctic) Loons, Great Greys, Black, and Pomarine Skuas; Townsend's Woodpeckers, Canada Jays, Pine Grosbeaks, Chickadees, Redpolls, Robins, Juncos, White-throats and Tree Sparrows, several warblers as the Townsend, Blackpoll, Heron, and Wilson's Blackcap. Equally characteristic southern birds are: Wild Turkey, Mourning Dove, Red-shouldered and Spotted Hawks, Yellow-bellied Cuckoo, Red-tailed Wood-

peaks, Chats, Whippoorwill, Kingbird, Least Flycatcher, Orchard Oriole, Cardinal, Grasshopper Sparrow, House Sparrow, Field Sparrow, Yellow-bellied Sapsucker, Flicker, Blue-winged, and Hooded Warblers, Yellow-bellied Cuckoo, Marsh Wren, Mockingbird, and Wood Thrush. Many others could be added. A more exact study of the ranges of these birds will show that nearly any two species occupy the same range farther north, others farther south according to their special preference for different sorts of country, its vegetation, or other conditions.

Changes in distribution are now now taking place rather rapidly as we close the original forests, transforming them because of man's use, wooded hillside into orchards, or pine and spruce woods into oak and hickory woods. The rapid withdrawal of the Red-bellied Hawk from northern and central New England and the advance here our White-throated sparrow of the Red-bellied Hawk have taken place within the last fifty years, and other similar changes could be continued at length. In western China that is because cultivation and over-crowding of population has resulted in such wide destruction of forests that to the present day, all that we know of the breeding birds of this great area is derived from those species that still are found in places where occasional groves have been preserved, as in the several provinces of simple peasants.

As to the larger aspect of the problem of distribution, I cannot do better than refer the reader to Mayhew's "Climate and Distribution" (1912), a masterly review of what we may deduce from the present and past distribution chiefly of mammals, for which the records from birds are few known. The same lines of reasoning doubtless apply

however, in other groups of animals and plants. His chief claim is that the continents have had more or less the same general outline as shown by now, up to the ice-maximum period, subject, however, to periodic and relatively slight changes of level. For what we call these follows a long period of wearing down of the land to broadlands, with slight ridgings along certain lines as regular pressure of the material worked down by the action of currents and winds. The result of this wearing-down process is the removal of high mountains, a more uniform temperature everywhere, and surface of large areas of land by shallow seas. The readjustment process involves an uplift along certain lines of stress, with the rising of mountain ranges, which, by drying the winds, cause drier conditions in the interior of continents, while the water period subsides in the formation of lagoons or glaciers at the poles and on high mountains. We have just passed through such a period, or may still be in it. The uplift may make land connections between what were before isolated areas, just as a depressive makes islands out of what was a body of continuous land.

It seems, we suppose, Mather's method of looking at a map of the world as seen from the North Pole rather than spread out on the rectangle of Mercator's projection, is so obvious that the great land masses are in the northern hemisphere. Therefore here the distribution of evolution and fauna, as the greatest area of all, was doubtless the most important. From the North Pole viewpoint, America, Africa, and South America are really the upper portions of the great central land area, and by very slight elevation it becomes possible to join the southern portions together, particularly by way of Asia. The shading of related

groups of birds in China and South America is now readily explained. If we suppose that they have spread out from a more northern source into these southern regions by way of the land Europe or a peninsula of that kind. From this point of origin (probably somewhere, somewhere west of the ocean, we have spread out from there, down to there, finally reaching the southern extreme corners. So the polarized similar-like birds reached opposite ends of the globe by spreading from the north, not by following a direct connection between China and South America. The two, instead of the straight line (and) is there any connection, the birds reached from Europe, where the birds are larger which show that in early Tertiary times they ranged further north than now and so, if they lived in northwestern Asia as well, could have crossed to North America when the two continents were joined and the climate was warmer as it now, where have in the early Tertiary. Later, with increasing cold, they retreated southward, and our cold birds became isolated, one in the Old World, one in the New. No, this can be explained many other equally reasonable, such as the occurrence of a true alligator in China and in our southern states; and alligators in our southeast and again in the highlands of northwestern China. These facts but emphasize the importance of knowing the historical factor if we would explain what seems relatively peculiar and impossible distribution.

Another interesting problem is offered by the occurrence of species on islands far from the nearest land. Did they come by some unusual device, transportation of an organism on floating logs, or did they reach their present home at a time when the land was continuous between the continent and what is now an island? The latter can



These authors were aware of the fact that the United States "is an armed country" and that the United States "is a country that is a threat to the peace of the world."

plantation, seems probable in case of Australia with its remarkable fauna of so many living species about the line elsewhere so largely dead out. But here the volcanic island nations must have been of very long duration. Colonization less clear. The isolation of tropical islands has often been desirable for the development of large and dignified forms, as the *Quadrupes* of Madagascar, the *Moa* of New Zealand, and the *Elephas* of Ceylon. For here there were no enemies and with plenty of food to feed them and no hindrance to their development in size. Through the protection of this isolation, too, it has often happened that birds have survived for long periods, while their relatives on the mainland have quite died out. This we see in numerous instances in our West Indies, as well as among the Pacific Islands, so that many species are preserved to us which otherwise would long since have passed beyond our ken.

CHAPTER III

THE PROBLEM OF ECOLOGY OF MAN

THE word "ecology" is derived from two Greek words that mean the study of the "house" or the surroundings in which a being lives. These surroundings include not only the general environment but also the other plants and animals with which this being is brought into contact. The study of ecology, therefore, includes the relations of kinds to their habitat as well as their relations to the other kinds and animals that live with them. It includes also a study of the way in which the kind affects its environment.

It must keep in mind not only that the conditions we now see among living species are an end result of a long process of adjustment among a great number of beings with different requirements, but also that there is a greater or less readjustment constantly going on as the general conditions of life change, whether in periods of relatively few years or over a span of ages. For example, with the introduction of the European House Sparrow into this country, there was at first a great struggle in its numbers, and a period of years in which it struggled for a foothold in the greatest or less detriment of many native species of birds. At last (were the numbers never to be less in general than thirty years ago, and the bird is gradually taking its due place as a permanent member of our fauna, subject to the factors of natural selection that hold it firm too great

an increase. There has been therefore a change or readjustment of relations in the space of comparatively few years. On the other hand there are indications that some of the birds were already over numerous periods of time. We know for example that most if not nearly all northern species of mammals are different in greater or less degree from the related species that populated their territory in some pre-prolonged period, as for example the bison in middle Territory of North America side its wealth of an identical form. These have gradually disappeared and have been replaced in part at least by the lower species. What is true the mammals is no doubtless the birds. There has been a slow change, accompanied by extinction of some groups and the expansion of others. This is therefore a factor in the study of ecology as we shall see presently in a similar way in considering the extension of the biological.

In a consideration of the general physical environment of birds, C. C. Adams suggests three primary divisions (1) water, (2) land, and (3) an intermediate ground, the shore. These in general are the surroundings in which modern birds spend at least a large part of their lives, and these again may be variously subdivided. The obvious one these divisions that the birds characterize off with are other groups of respectively as water birds, landbirds, and shore birds, though this classification is at best a rough one. There is of course nothing specially new in this, but it serves to emphasize the fact that birds have become adapted to particular modes of life, especially as certain methods of procuring their food, so that they have come to be more and more dependent upon the special kinds of environment, just as the plant or animal life on which they feed has been

have become accustomed to a somewhat wet and particular set of conditions.

In more detail, the water environment may be divided into (I) salt water and (2) fresh water. Salt water includes the oceans and the spaces of bays that hug them in, but by it, and almost aside from it, are groups of very many (II) rivers that range along the coast (including estuaries) and (III) those that range farther inland to the inland species. To the former (including all coastal species) may be referred such as the white gull, Atlantic petrel, the Common and Arctic Terns, and a number of ducks, especially of the group known as sea ducks or diving ducks, species that seek their food at moderate depths along the shores, diving for mollusks and small fish that come to the bottom. Other illustrations readily come to mind, of birds that are not, of place inland, that seek their prey along the edge of the sea, returning therefore to the shore at immediate necessity for this purpose. Intermediate steps are seen in the degree of transposition from the land, for many diving ducks, as Redhead, Canvasbacks, Scaup, and sea island birds number but seek the waters for the overwintering periods. The second class, or pelagic birds, has departed even farther from the primordially shore life, and like the petrels and albatrosses are at home on the open sea, seldom coming within five or ten miles for the most at less prolonged resting periods. These two classes of water birds may be thought of as dividing into "the world of waters" just as we find on land certain species that have reached shores and become adapted for the marine conditions imposed by these extreme types of environments. One is perhaps like man made by a somewhat specialized one. Pelagic birds such

on the ponds and their other uses in life in small low stream channels, and as most have retained powers of flight, hence they have developed special ways of flight such as soaring in the larger species or, as in shorebirds and even many of the lesser species of ponds, a continuous flow of flapping followed by a long glide. They must be able to rise upon the water surface for longer or shorter periods, a thing which some water birds, including some swans, have been found incapable of doing. Perhaps birds are therefore restricted in well as in the use of sustained flight, and not, but on the water without becoming waterlogged. They must be largely surface feeders, and those that rise upon various kinds of sea animals that come to the surface by sight, such as rapid and various small crustaceans, must become in great measure.

Birds adapted to a life in on the fresh waters are probably in less varied company than those of salt water. For the sea, except towards the poles, is always there or less open, and even if birds are forced away from ponds rivers by the ascending of waters, they can find their way to permanently open areas by a continuous water path. This is not always the case with fresh waters. Lakes and ponds freeze completely even in high latitudes so that birds that have resorted to such places are forced out and must select by flight over land to other favorable areas of fresh water. Even the direct theory is the truth, so that the fresh-water habitat becomes in the temperate and higher zones more or less discontinuous according to season. It is because of this difference, I presume, that flightlessness through reduction of the wings has not been developed in birds frequenting fresh waters, whereas among sea birds it is common. Thus the entire order embracing the Grebe

gulls have lost the power of flight through having developed the wing into a paddle. The Great Auk is an example of a species that has spent its wing more satisfactorily for flight under water than in the air, and as was able to disperse into certain flight over the water even in an interrupted. In the Caribbean Islands of the west coast of North America, Florida's Cooters has reached a like condition, and though in other respects a cormorant, has such webbed wings that they are no longer available for flight. These cormorants normally swim under water in masses of ten feet above, this one differs completely from that of the Great Auk, for the small size of the wings seems to be due to a degeneration of the wing through disuse, whereas in the Great Auk the small size seems the better to do it but not as a paddle in flight under water. It seems probable, too, that the extinct *Chaparral*, the great *Hesperia* of the Cretaceous period, was a similar, and though its fossil remains are found in the far interior of North America, is probably lived on a time when this area was occupied by an inland sea. The possibility of the sea as an environment in that its itself is shown in the distribution of certain birds.

The present lecture concerning the distribution of our birds, its nature and way of migration. In a recent account of the seabirds of the Cape Verde Islands off western Africa, Sir H. C. Murphy has brought out some interesting facts. The outstanding feature is the absence of gulls and particularly of some of the breeding birds. Apparently not even the species of the *Macropodina* family (Larks) were in this group of islands, although in the Canary and Madeira Islands not far to the north-west of the Cape Verde Islands, and there is a gull in the Azores. The Cape

Florida. Mounds share with the West Indian small birds (shore birds, terns, the Brown Boobies and the Tropic Bird) that both the Florida and West Indies is common to the same latitude in the Caribbean Sea. Some latitude factor, as it were, holds off the Common Tern on the north and the two latter species on the south and west. Dr. Schlegel then shows that a broad belt of warm water separates the southern nesting limits of the Florida and Key Terns (which are tropical species). The surface temperature of this broad belt is not high to be desirable for the Common Tern, and this fact that the two tropical species, when absent there, live from the Cape Verde as well as from the Bermudas on this side is correlated with the fact that both island groups lie within this belt. The southern boundary of this zone is about 30° N. and its northernly limit, 40° N., and extends about the distance from central Florida to Cape Hatteras on our coast. The interesting point is not that the water-temperature is of direct influence in the distribution of the birds but that it affects them in some indirect way through its influence perhaps on their food supply, which again is controlled by various factors. The temperature of the surface water therefore is but one of the ecological factors that control the breeding ranges of these terns, but its influence, though indirect, may be considered already.

Again, Dr. Murphy points out that the abundance of boobies, Tropic Birds, and petrels at the Cape Verde Islands is probably to be correlated with the topography of "the surrounding seabottoms in comparison with currents and motions produced by the numerous slopes of the islands . . . compelling a constant updraft of supply

of varied food supplies appropriate for their species to approach the surface." He adds that the great efficiency of the Laysan Island of the Pacific, may be made possible by the mere swallowing of the birds about this island, so that a commensurate is produced of the vast quantities of aphelognaths needed to support these birds. (See according to Fisher's estimate the consumption of these by the breeding albatrosses amounts to about two tons daily.)

But we know as a classification of water environments. There are fresh water lakes and streams, whether large or small, and are characterized by a number of familiar birds. The same various species, certain of the smaller gulls (see Franklin's Gull), Black Throats, many of the surface-feeding loons, and the Grebe are birds typical of fresh-water lakes, while others, as the Pintail or Merganser and the groups of North American ducks known as Pintail Ducks, are especially characteristic of streams. The latter birds, which frequent rapid waters and often climb out on to rocks, using the sharp spurs at the end of the wings to help them. Here may be included also the Egrets, and spoon-billed lobes, who plunge boldly into numerous streams in such food as the bottom, truly an extraordinary habit for a Pinniped bird.

There is a distinct type of environment may be thought of as very distinctive extent, and appearance various to get, but chiefly comprising one cluster of birds and mostly known as Lake. Each type has its characteristic, together with the Piping and Black-throated Phalarope, the Long-billed and White-winged Sandpipers are typical of the mud banks, the Lesser and Greater Sandpipers and the Tattlers are birds of muddy or brackish shores. (See

marshes may also be included as shrubs, and have been invaded by a few birds of the land as Bewick's and Sharp-tailed Sparrows. Adams points out that the water marsh, laid up as it is here is composed of small ponds with grassy levees between, somewhat comparable to a shore, so that it becomes the breeding home of many shore-loving birds, including sandpipers, curlews, and plovers.

Probably shallow swamps should be considered also as a variety of shore, or as an intermediate step between shore and land. Fresh and brackish swamps have each their special set of birds, the fresh swamps, however, a more varied lot, as being more nearly like the land. A good example of various freshwater birds of along have come off swamps is afforded by the Tupper Bird and the King Bird, both differing in their swamp general distribution, the former a subsarctic species, the latter more characteristic of freshwater marshes.

Freshwater swamps are divisible into various kinds, as those filled by grass, those overgrown by willows, or those grown up to bushes or trees. The cattail marsh has a specially interesting set of birds that grow with it, including Least Bittern and Long-billed Marsh Wren; while grass swamps are equally characterized by Swamp Sparrow and Marsh-like Marsh Wren. Other species may occur in both as Red-winged and Yellow-headed Blackbirds, Hens and Virginia Rail.

Swamps are especially interesting as often containing refuge of species formerly more widespread, or they may offer conditions quite different from those of the immediately surrounding country. With us in Mississippi, swamps are in which is dense growth of cotton-buds, hence a distinctive ecology, providing rapid evaporation,

often occurs on lowland islands, where good conditions should also occasionally obtain with some southerly birds as seen on Canada Warbler, Winter Wren, House Wren, Rock Wren, and Mockers. Very few such observations seem to have been made as to the present conditions obtaining in such places.

The distribution of forest environments may be correlated not with a considerable degree of richness, but the understanding features are directed towards and upon ecology. The forest types, which with the type of forest forest. In North America, the chief forest types are (1) the great mountainous evergreen forest; (2) the hardwoods of the eastern forest, and (3) the western pine forest. The first of these corresponds more or less closely with the forest zone of Eurasia, and carries its distinctive fauna, many of whose members are directly related to those of the evergreen forest zone in the south of the Old World. The principal hardwoods of Appalachians forest has likewise its own set of species, and the western pine forests are still different in character. The attempts to divide these forest into climate zones is less satisfactory. Thomas has shown that the distribution of forests depends not only upon temperature but on other equally important factors of soil and moisture, which in turn are conditioned more or less by geological and topographical features. Ecology is dependent in its distribution upon these factors only in directly as they affect the distribution of the forests. The site of the great mountain divides as the Pacific slope, with the resulting reduction in maintenance of the growing season which was a large factor in the development of what seems to have been a much greater amount of richness of forest in western Tertiary than there was

so that the gradual extent of the forest from the far western United States has brought about great changes in the distributions of birds and other animals. The drying out of the winds as they come from the Pacific Ocean through the mountaining of mountains on the coast brings in the immediate onset of desert conditions in the West, while in the central United States the gradually increasing arid moisture makes its progress and gradually adds a special set of birds adapted for this environment, until conditions are finally reached suitable for desert growth in the East.

These geographic distributions are not necessarily causal, as we often thought of, but due to the effect in much with the relative amount of available water. Climate and others have brought out this fact in dealing with fishes, where two chief causal areas result of the factors are (1) the degree rain forest with its abundant precipitation, (2) the dry strips or semi-deserts including the various and arid parts of the continent and including the Great Salt. When the transition between the two is extremely abrupt and sharply defined.

Desert areas are ecologically a kind of desert, the plant growth is largely prevented not so much by a lack of moisture as by water being to a great degree unavailable through lack of heat and light. The similarity of the birds to a step or semi-deserting forest is interestingly shown by the presence in both types of numbers of such birds as quail, ground hawk, a grouse (Pinniped) and by the presence of hawks, hawks, and owls. The avifauna is of course quite different from the forest desert in many ways, but both agree in showing such significant differences of life that few relatively few structures can penetrate and live in them. We may think of the birds of

forms in creation that have located their homes upon adjacent but more favorable spots of country. In a few cases the surrounding water is the source of life to waterfowl. Some point out that certain birds inhabit the fringes of swamps but come in the forenoon to some pond where they secure their usual supply with drinking, so that the pond for drinking water becomes a feeding place in their estimation. An example is the Pintail Quail of California that remains out as long as the dawn, but retires into the marsh along the streams when it grows so dark that hunting becomes too perilous. The downy-bellied sand-plover of the Old World has an interesting habit of carrying the largest feathers with it at all times as they drink, and bring them to the nest. The young birds derive their water supply by passing these saturated feathers through their bills, and until able to fly they never leave the water way.

In the relations of birds to insects there is much yet to be more thoroughly studied. Many birds are especially true destroyers, often showing preferences for particular kinds of insects, or for indicating some instance of dependence upon them with their capture. Thus in western New England the Pine-creeping Warbler shows a very decided preference for the Pine Tree, the Black-throated Green Warbler is partial to the White Pine, the Blue-jay Warbler to Red or White Spruce, in each of that there must be some as yet undetermined reason necessary for this dependence. Probably the nature of the food has much to do with it.

The fondness of the Herring Gull for the seeds of the downy-leaved Maple or Red Elder is apparently suspiciously like the wild attraction of this bird's almost range to New England in recent years. A trial of the Herring-

is occasionally seen in winter in the Middle States, as far west as Illinois. It was often captured in New England until the advent of a large flock in considerable numbers of these handsome birds last year. Small flocks were seen at various times in that winter in central New England. This occurrence was looked upon as wholly accidental and extraordinary, and no further examples were seen here the next winter year. Early in the present season, however, a second flight came in again, and since then hardly a winter has passed without some report of this species in the East, either in large flocks. Very interesting is the way in which these winter's reports of birds in the New States, resulting in the raising of considerable sums until the supply of the birds is exhausted. The first suggestion, I think, by the late Mr. Walter Faxon, is likely that the extensive planting of this tree through the middle west of the United States and Canada, as well as in New England (in a large degree), has been the important factor of attraction. The object of some of the best birds acted as bait to call the birds across from their usual wintering haunts in the West, so that as the nesting season became almost continuous in their home-country distribution, the birds followed, and having once found the way they have continued to come with quite as great regularity as swarms of our other reported visitors of winter. Still more interesting in the fact, recently told me by Frederick Steadman, of St. Albansburg, that in southwestern Russia, where this tree has been extensively planted, the Blackbirds, a more northern of the Fringing Family, has been similarly lured across the plain the trees in great winter sums in that country.

The introduction of other trees than the Red Elms has

had no important influence on birds. Especially, I think, the apple tree has been a large factor in the fate of many species. The resemblance with which Redwing, Chipping Sparrow, and other species have taken to the orchard seems to me to be less than the mimicry with which many warblers and other insects have done the same. The abundance of apple-trees over large and small areas has done more harm here than good. A great factor in increasing the number of these birds in our rural districts. A recent writer has shown that the planting of apple orchards in Cheshire in late years is directly responsible for the gradual spread of the Redwing across that tract from east to west and of one of the Kingbirds in the opposite direction. There does in another way where overplanting has resulted in an increase of the birds here now existing.

Birds in relation to forest vegetation is a matter needing further study. The gradual replacement of one type of forest or plant growth by another may take place under natural conditions or following the artificial clearing of forests. Many of our winter ranges may easily be seen in the growing stages now now have been a forest. These different stages may still be found between (1) growth in which one and is beginning to fill up with the accumulation of dead leaves and branches of various kinds; (2) growth in which this accumulation is enough to form a growing log extending in from the stream, and supporting bush growth near the margin; or (3) dead ranges where the greater solidity of the position near the original stream makes possible a log of white-pine growth, beyond which are tall hemlock and clusters of blackberry, and beyond lower brush, and the lower ring is covered with its sphagnum, pitcher-plants, and sedges. Each of these types of growth has its

particular birds. The Song Sparrows are found in the lower grassy stage, Song Sparrows and Yellowthroats in the lower forest; while in the rich forest growth the Canada Warblers mostly occur. The final condition of the process of filling up results in a large rich swamp, which supports a number of more northern species of animals.

The coming off of New England forests and their denudation by fire introduces other types of succession. A white pine forest cut off in western New Hampshire may not reproduce itself easily. The bare ground slowly recovers and a growth of bushes and other shrubs, the forest of such birds as Song Sparrows, White-throats, sometimes Chipping and House Wrenners, Yellowthroats and Chamaeleeked Flickers. Usually grey-birds flourish, many small white winged subspecies eagles, which are never excluded and often checked or much reduced. As this stage the growing forest is excellent cover for grouse. As grassy pine and the trees become a pole forest, the Chamaeleeked flickers gradually die out and a new pine forest may result, with again a characteristic bird fauna, including Blue Jays, Crows, Black-chinned Green Warblers, and others. As a succession of forest stages means a succession as well of its bird inhabitants. This is also characteristic grassy areas, for example, gradually lose attractiveness for many birds and eventually hold them up there as in reduced numbers in the forest succession mentioned.

The Chamaeleeked Flicker is a bird which no more lives now elsewhere where birds again growth offers the same of cover is made. Perhaps some like change in our agricultural area such as the giving up of wheat crops has had an influence on the Chamaeleeked, formerly a New England bird.

While the gradual change from one type of forest growth

as another under natural conditions results in a gradual maturation of first larvae from green-living to black-living eggs, and from small-size larvae to typical birds, over a long period of years, we may see the different stages thus traced by separate green birds and those that are in the different transition stages. This natural maturation is there fore responsible for gradual changes in any form, resulting in what is called the change stage where the dominant type of form at length prevails, and as in any small-sized parental form, however at length with propagating. In the contrary nature, however, this change comes in at different times.

Because of form and form through natural change, we may see a complete form in nature. Now England, where change is growing up into birds, and there is lots to think, but mostly at high form. The specially increasing type is produced here through natural breeding of the larvae in spring. These larvae then will sprouting birds and adults, and finally result in the death of nearly all the over-ripe form, when the low, matured birds will still other repeated breeding there in life is possible growth of green birds, white plum, and such and, these species, which with the birds have been to be seen at low frequent and spring up again as often as the area is turned over. The birds that had this sort of growth repeated are *Prunella* and *Chamaea*, *Blackbird*, *Field Sparrow*, and *Chimney* especially, with a few *House Thrushes* and, as the growth becomes thicker and larger, *Fire-crowling Waddlers* in the place, *Goldfinch*, and *Chimney*. There is much to be done in the way of a more careful study of these different types of reproductive growth and their characteristic birds especially by means of observations, noting the gradual change of a given bird and the maturation

of different species, the distribution of any special number from of species, and kind of habitat.

Such an examination of birds may play an important part in forest management. In Europe the large Yellow Throat has made so the wide the spread and survival of the mistletoe. The berry includes a layer of sticky substance which hardens on exposure to air and is used by many bird-lime. When the Throat eats the berries, it carries the seeds, which often stick to the bill and have to be rubbed off against a branch. The sticky substance then hardens and the seed is kept until it germinates within months later when it finds the temperature is sufficiently high. Professor Brehm told of a certain telegraph wire in Egypt, where every year hundreds of swillings of an allied species of mistletoe appear. These come from seeds rubbed off upon the wire by birds from their bills. They do not last long, however, as no mistletoe is able to live from the wire, but they show how important birds may be in the distribution of the species.

There are the birds about forests in forest a considerable growth of red and white hemlock's characteristic forest of the tree growth. It is noticeable how subject to pasture lands and other open fields, as a considerable distance from the nearest collection will be observed from a spreading of small swillings, the formation of more "white patches." These swillings are undoubtedly from seeds upon a fall by birds that feed on the berries and then deposit in these places upon which seed will the undigested seeds. In New Jersey it is said that the Robins scatter the seeds of this tree along the rail fence where they perch, so that even if no seeds grow up along the pasture boundaries. Robins eat not only under berries but also those of the ground juniper.

The seeds pass through the digestive tract, and thus apparently in an active state germination. Indeed, Mr. William Brewster once told me that his attempts to grow ground-swarmer bees and wasps always succeeded until he discovered that in order to germinate, the seeds must first be eaten by a bird and passed through its digestive tract. Birds are also fond of eating two species of wild cherry in full, both the Red Cherry and the Black Cherry. After the pulp is digested, the seeds are voided in a condition in which germination is probably assisted. Many of us are familiar with the fact that old haggard seeds in the New England and Illinois woods all up with a few years' rest. Red Chert, an Illinois seed, has undoubtedly been thus saved, in large part by birds, that gather in full in open places in the woods. In this way the birds help us explain the fact now so essential for the retention of moisture and for the exposure of the more valuable seed. They provide also for a ventilation of these buried stores, effect seedlings. These species of birds probably are instrumental in the planting also.

On the other hand, there are probably instances when birds do harm, as in case of those that eat primarily berries, and so help us nearer this serious phase. Crickets have been known to be a considerable factor in preventing complete colonization of certain sections, in years when the seed crop was depended upon to replace the losses that crickets bring. Again, it seems fairly certain that the dove, and pigeon, whose droppings have no disinfectant or chemical value in many United States, may be viewed in part through the agency of birds in transporting the seeds to their chambers. There are but a few of the ways in which

birds are intimately connected with the culture of the Forest.

There are some very interesting relations among birds with regard to size. It is noticeable in Canada, not only among birds but among mammals as well, that there exist in two species apparently closely similar in appearance and inhabiting much the same general area, but differing largely in size. A familiar case is that of the Hairy and the Downy Woodpeckers, birds which differ chiefly in size but have similar plumage. In this case the under side of the tail in the Downy is barred with black, whereas in the Hairy, the tail is usually unmarked below. Another case is that of our two species of Yellowlegs, the Greater and the Lesser. In Europe, the Flemish Gull and the Lesser Black-headed Gull are two familiar species of the English coast, which are practically alike except in size and in the color of the crown and the feet, yet they live harmoniously together for all that we can see. In all such cases I believe that some difference in habits goes with this difference in size, though the distinction may not be very great. All the Eastern and Western Woodpeckers, both obtain much of their food especially in winter, by searching the crevices of dead or dying, but in a large percentage of the cases it will be found that the Downy extracts its language to the smaller branches, even to the tips of some, or of others, whereas the larger extracts its more solid food from much larger limbs. Thus the smaller bird has the advantage in its larger range of work, for it can hunt over the tops of larger trees and branches and thus extend its search over a smaller range among which the Hairy would be lost at times. Hence, then, we see a beginning of a specialism.

don which results in a restriction of the larger species to a more limited feeding area. Further increase of don would limit the field of action still more, as the use is made of the Filament Woodpecker which is dependent on a large don. In the great specialization in the structure of the woodpecker's bill, therefore, there are long a decided advantages when it can be compensated by an ability to reach a more abundant food supply. Thus the Filament Woodpecker may perhaps have done its part, for the larger don and increased power enables it to cut great holes in the trunks of forest trees in order to reach the contents of the big wide wood-boring nests which others cannot lay from the hole, having their galleries in the thin-skinned bark up into the stem. The female dependent upon food of this sort, however, is in itself a specialization, and implies a reliance upon more particular conditions, the failure of any one of which may spell disaster. Thus large ones in New England, for example, are more and more becoming confined to one district, and not more rare in suitable tree than big ones. The range independence of the Filament Woodpecker may therefore depend in part upon the regularity of these nests and in turn the supply must be sufficient and widespread, which means a large number of trees, a certain proportion only of which may be suitable for the maintenance of this supply. In the diminishing ratio of downy, hairy, and Filament Woodpeckers, we may have an increasing degree of specialization, or at leastness in certain respects the food getting. There here is some help to explain why the Downy is commoner than the Hairy and the Hairy is more numerous than the Filament, while the last increase and with changed conditions of Forest Birds' life is changes of being wiped out.

The difference in the two species of Tallowhags may be considered with feeding habits in a similar way. The Lesser Tallowhag is shorter-legged and shorter-billed than the larger relative. Its feeding habits, however, are similar in that both frequent muddy places, and the edges of ponds. Feeding is often up to their thighs and probing up food particles in the mud as in shallow water. The Greater Tallowhag by reason of its longer legs, however, can reach into deeper water than the Lesser and its longer bill and neck additionally increase its potential feeding range. It should follow that the larger species, especially so when we compare with the woodpeckers, would have more of a slight advantage, on account of its ability to obtain food from a wider range of depths in the ponds which it frequents. It may be observed that this is a factor in the usual greater abundance of the larger species, its longer stay with us in the fall migration, and its regular presence in spring. For the Lesser Tallowhag is rare here as a spring migrant and is still less proved by late summer, whereas the Greater stays till late in November. Thus it appears that proportionate small numbers of one may be of great importance. Yet a further large increase in proportion of the Greater Tallowhag might prove a disadvantage, requiring as such more food on materials a body much larger than the advantage of a greater feeding radius would be lost. There are thus factors tending to limit the extent to which one species may profitably exceed another of similar feeding requirements.

Among the group of birds called Tallowhags (Percollidae, Struthio), including the grebe, ibis, and others, we find birds of very great diversity of size; yet all pelagic species obtaining food under more or less the

conditions. Nichols, who has studied these birds in a long series of trips to the southern coast where they nest abundantly, has brought out some interesting points. He placed the body-lengths of the various species of the group, with the exception of the Diego Petrel which differs in different, well known the nesting caves in these three well-separated parts, who is informed the three chief groups of them—the first including the smaller Island Group's Chicks, the second the medium-sized shore species and fulmars, the third, the larger albatrosses. These birds are all pelagic and sometimes practically the entire aerial population of the southern coast below the Tropics. Nichols says that in one "family with their breeding and feeding habits" is probably showing that the great range in the various phases of competition" but found in this vast population. Thus the "small Wilson's Petrel or Island Group's Chicks, the medium-sized Cape Petrel, and the large albatrosses collect in one time to partake of scraps from a ship, and the smaller birds are said. And with the smaller birds by the larger ones." In their breeding habits these birds show further the results of this size relation. For they nest relatively small land areas such as islands at the edges of the southern continent. There again the numbers of birds are brought together in their proximity where competition for food is keen and where a smaller species is exposed no longer than a larger through having its eggs and young more or less killed for food. He says that the smaller forms nesting hereafter where they will be easily out of reach of the larger species. Some species of nesting habits are sometimes among smaller while the large and powerful species build in the open. It is found, too, that the same species will collect in one

game and breeding. In this way small and delicate species are able to live in competition with a species as hard and larger and more powerful birds.

There are other interesting relations in birds that need explanation through a study of their habits and behavior. For example, the significance of the often greatly superior size of the female over the male in birds seems to have received very little attention. The disadvantage of being small or the advantage of being larger was brought out by a conversation in "The Duke," describing a scene witnessed in Florida. The small male of a pair of Bald Eagles was, by now, the woman had just swooped upon a Fish Hawk standing in a deep in grass, a fish, apparently of unusual size. With covering over the Eagle closed after it, uttering its hoarse cry. The heavy was the fish, however, that the Eagle was unable to rise with it, but was forced to a gradually sinking motion. Presently it dropped the fish with a peculiar cry, to which its larger and heavier half at once replied, both now perched and down like an arrow after the fish, reaching it when it had nearly reached the water, and with repetition although there is none in the early appearance is that of competition between the two sexes.

CHAPTER VIII

THE SEX DIFFERENCE IN BIRDS

In all vertebrate (fish-boned) animals, the reproductive organs are paired glands, which in birds like human differenced into male and female (the male of the species, the female). In the chick this difference can be detected as early as the fifth day of incubation. Curiously, in birds the development of the ovary on the right side generally lags, leaving the ovary of the left side as much fully matured and given rise to the eggs by the hatching of the parental cells. In no other group of animals is this known, except in some of certain fishes. It is supposed to be connected with the large size of bird's eggs and the necessity that while inside the body of mother there, the ovum can lay its nucleus, a different side more than a single egg within could easily have (though more likely the egg would). Very recently, Chase (1921) has shown that in spite of this general rule among birds, it is nevertheless not at all pronounced in that both ovaries well developed among certain birds and fishes. This investigator found double ovaries in 13 out of 47 of those birds, and in birds of other groups he found no more out of 10 in which both ovaries were present, including such famous birds, Red Grouse, Bonaparte's Grouse, Pinnipeds, and Little Gulls. Additional observations on this matter are desirable and can easily be made by those having to prepare specimens.

The eggs of birds are first given off by the ovary, and

quitted with off a single continuous cell, the upper from which the shell develops. The size is a result of the quantity of yolk or nutritive material with which the cell is filled. On being given off by the ovary, the egg is caught by the trumpet-shaped end of the oviduct, a tubular organ down which the egg is passed by a series of muscular contractions, and it comes out as the "laid." On its journey down the oviduct, it passes by various sets of special glands, the first of which covers it with the gelatinous albumen or "white," the next covers it with a double skin or membrane, and the final set sets a long shell, which may or may not be colored.

We have all seen occasionally the so-called "double-eggs" laid by hens. There are two chief sorts (see Fisher, *op. cit.*): those in which there are two yolk enclosed by a single shell, and those in which an egg with yolk and shell is enclosed inside another complete egg. Sometimes these separate egg-layers have shared one female ovary. Where an egg has two yolks, it means that there are two separate eggs given off together as usually is, that have traveled down the oviduct side by side, so as to be caught by the other end, skin, and shell as one mass. Where one complete egg is found one inside the other, the case is different, for obviously the lower one must have reached the lower end of the oviduct before the double-yolked egg, before the outer one. Illustrations of such eggs seem to prove beyond doubt that after the first or lower egg has been completed a parallel reversal of the wave-like contractions of the oviduct takes place so that the completed egg is carried back to the upper end of the oviduct where it started. There is usually a second egg accompanying the lower and the two go together past the albumen, skin, and shell-

plants, as does the first egg, is completely enclosed by the albumen, this condition of the second. Sometimes eggs are made in rounded layers the second is rejected and on its way down has not formed but under the body wrings itself, and thus causes the death of the bird. It is a curious fact that the majority of double-yolked eggs are laid during the summer part of the year, from May to August, while single eggs are produced in the winter and spring (see Fisher, 1907).

An unusual bird during the Great War was seen by the inquirer, down some eggs she had received from the market. They were larger and stranger than usual, and having seen in the papers that the eggs of alligators were being sold for those of hens, she feared she was being deceived this way. I assured her they could not be other than extremely large eggs, for alligator eggs could not be laid in quantity, and she seemed satisfied. But eggs of Hawks, alligators, and crocodiles are on a scale much larger in proportion to width than in height, though those of some large turtles are nearly spherical. Eggs of alligators, on the other hand, related probably to the weakness of height, have recently been found to be in Memphis, with even the extended embryos inside them. These eggs are very narrow and long in proportion to width.

The shape of bird eggs are more various than are would at first appear. There also have been the finding of the Great West (Captain Townsend's discovery of the first that laid square eggs). But though his tale is discarded, there are nevertheless many variations from the simple oval that we know so well in the hen's egg. This field is subject to much discussion in fact, but since bird's eggs are long or pointed, others nearly spherical. In

the shore of Hudson's river, about far exceeding the long pointed eggs, the shore were believed to be more delicate, with a clearer "white." It was also supposed that such eggs would produce males, the shore and rounded more the males, though we now know that this is not at all accurate. Various types of eggs are known to have characteristic of particular groups of birds. Thus it is noted among the sandpeeps to have four eggs of a distinctly pear-shape, that is the small end is almost round. In the case the pointed ends lie at the center, and the shape is perhaps an adaptation to allow the bird to cover an large a number in incubating. For they lie down together that if they were oval or elliptical like the eggs of loons or loons respectively. The eggs are large for the size of the bird to permit of storing a quantity of yolk in which the embryo may feed, for the young of these birds are able to run and swim the same way shortly after hatching. The shape of the swans and geese to shore birds is believed has similar pear-shape of their egg. But swans lay only one, and instead of a new, usually when a pair on the edge of a hill, where when the egg rolls off if the birds are suddenly disturbed. Yet, as has often been pointed out, the pear shape is an advantage here, for, if slightly raised, the egg tends to revolve upon its smaller end instead of rolling away, and as no doubt is an advantage from going over the edge to destruction. Dr. Chapman has again termed these "diplo-mere" eggs, as their shape allows them to move without going far.

Loons and loons lay nearly spherical eggs, and in this respect are supposed by some to be primitive. Yet the loon, which might be considered still more primitive, has a long, elliptical egg. Butler has suggested that the spherical

stage with its keeping the eggs all together, it held in reserve. But probably this is only an incidental matter, for monophagous, which have probably moved to various larger than ever, have elliptical eggs.

Eggs and Figure.—Evidently a very interesting relation between the form of the egg and the extent of migration is also being being in, has been studied by Howell (1923), who produces a graphic statement of Lyman's (1911) idea, that the short diameter of the egg, that it corresponds to the radius of the orbit, is less variable than the long diameter, and that as increase in the amount of stored food, that is the amount of yolk and album, varies with the size of the individual, it follows that the greater the amount of food in the parent the size of the individual, the longer will the egg be, the more room for the yolk. For if an increase in size is needed, it takes place most easily in a longitudinal direction. The converse also is true that the less the amount of stored food, or the less the individual size of the bird, the shorter will be the egg.

Howell (1923) has applied this proposition to eggs of various birds to see the idea that a migratory species is more vigorous than a sedentary or nonmigratory one. He divides the birds by Howell, he ordered as a table which may be used to express the relative size of the species. In four sections, that found in the northern United States and southern, intermediate, north America,—namely, the Blackpoll, the Redpoll, the Black-throated, and the Yellow Warblers,—the table averaged 1.25 (ranging from 1.14-1.38) in four other species whose length of migration is much less,—namely, the Pileolated, the Myrtle, the Prairie, and the Northern Pike Warblers, that almost in part within the United States,—the table averages 1.20, the

leave being the Yellow Plover (1.24). For the Black-throated Blue is in 1.25, which, however, is as good as the average for his first group. With a second set of egg measurements, his results are 1.26 for the first group of species and 1.21 for the second. Two western warblers whose migration is short—Audubon's Black-throated thrush, Townsend's, Heron's, and Chisholm-backed—average 1.26 for one series of eggs, and 1.32 for additional eggs, which arrived fairly well worn given for the other set, and are much less than that (1.21) of the long-distance warblers. Other species of birds seem to general in conform to this rule: thus in the Northern Water-thrush, a bird of long migration, the ratio is 1.32, in the Louisiana Water-thrush, of shorter migration, it is 1.24; for the Red-winged Blackbird, 1.26, for the Orchard Oriole, 1.26, the latter with the first massive journey having the smaller ratio. Among sparrows, it is found that those breeding in high latitudes have a different shape of egg from those breeding in more southern latitudes, as expressed in the ratio of width to length. Thus, the Junco, White-throated, White-bellied, Lincoln's, and Pine Sparrows—all northern breeding species—show a general average of 1.26, while Grasshopper, Heron's, Heron's, Pine, and Redman's Sparrows (southern species) show an average of only 1.22. An example of this same relation, the ratio in the Great Blue Heron is 1.26, whereas in the Florida form,—Florida Heron, which is not migratory,—the ratio is 1.21.

Birds greatly differing in size cannot well be compared, for in the larger members of a group the length of egg seems to be proportionally greater: thus in the Great Auk and the Bonaparte Auk the ratio is 1.26 and 1.25, while in the smaller Black Chiffchaff and Heron's it is but 1.21

and 1.25 respectively, and all of the species have almost the same migratory range.

Several birds furnish what is various kinds of great power of vigorous flight, as swallows, pelicans, and hummingbirds; the eggs are relatively more elongated. Among the same, many of which are very little migratory, the eggs are more nearly spherical.

The colors of eggs are not especially varied. Besides including brown, white, greenish, and washed all lay white eggs with a shell that is only partly firm. The white bird's egg is therefore peculiar in being like that of the ancient reptilian ancestors of birds. It seems more likely that the white eggs of many interesting birds simply retain this ancestral trait rather than that the eggs are white because they are hidden from view, as might have suggested. This trait is found universally within each relatively primitive group as well, raptorial, and hummingbirds, some of which is known to lay speckled eggs. A great many of our small birds lay either as white eggs, while the brownish or greenish spots often arranged in a band about the larger ends. Most of our raptorial lay white eggs. It is interesting to see, however, that the Eagle's eggs are not really white, though very nearly white in their speckling. The question arises, then, is the Eagle's large the speckled eggs of egg, and in it developing a white egg because of nesting under dark ledges?

Birds whose nests lie open to view are apt to lay eggs with more or less color. Those of raptorial are marked as a brownish ground that may aid in their concealment when the bird is away. The above are many considerations to this, for pigeon, nearly all of which build open nests, all lay white eggs. The Nightbirds lay a speckled egg that

sharply delineated by indigo-blue, and as it is not conspicuous when exposed, nor its color visible when the egg is wet, with a similar habit of nesting on the bare ground, lays nearly white eggs with a few pale bluish spots. It may be that this is associated with a difference in habits, for the former often flies by day, but the latter is, I think, much more strictly nocturnal and is always all day concealing its bell-shaped eggs.

Curious are the shell-less eggs of the Raven, the greater part of the Crows, and the Blackish egg of the King.

The number of eggs laid is more or less characteristic of a species or of a group of related species, though there is, as usual with birds, no rule without its exceptions. Thus, some pigeons, catbirds, and juncos lay one egg. Two is the normal number in most pigeons, the hummingbirds, loons, and in many species of birds, while many small birds lay three, four or five. The Dove and the House Wren nest the least with about 12 and 13 respectively, and Red-bellied Woodpecker and Quail may lay 20 more. By taking more an egg at once as it is laid and having one only for a "nest egg," birds thus sometimes lay indeed as few as great numbers. Presumably the second is laid by a Plover that is said to have stretched nearly 70 in this way, a remarkable example of the action on the body of an undiluted instinct.

A large number of species lay but two eggs, and there are some singular variations among animals of these birds. In the Hawaiian there is a large species of Blue Gull (*Larus* and *Macrorhamphus*), a bird which in these regions takes the place of hawks in preying on its immediate neighbors. This bird lays two eggs, but it seems that only one chick ever lives to grow up, the other inevitably one of them

gets gilded up by one of the neighboring old Hens who were not so discriminating between the eggs and chicks of their own and other species of birds.

The Arctic Pigeon that lives in close proximity also has her eggs, and it is interesting to know that very soon one of the few chicks epitomizes the effort in growth since it certainly is getting away that its place of the hand-brought by the parents. Whether or not the mother breeds in variable hole to grow up would be interesting to ascertain.

Dr. F. M. Chapman notes that some of the species of Hawks or Ospreys lay two eggs, but when only one of the young survives, the one few chick hatches several days ahead of the other and commences to grow in parents' attention in the neglect of the other. That was what is one of the Quercus Larks that lays but two eggs, one egg is often found to be without, so that only one hatches.

Among pigeons, two eggs form the usual complement, though there are exceptions to this. The Passenger Pigeon, for example, laid but a single egg, and there is doubtless some significance in this breeding of the sole, perhaps to be connected with the fact that the bird was social in its habits, living and nesting in communities. We shall never know if there was a low rate of mortality through this breeding habit, but such was probably the case, and it allowed the species to maintain by reducing the number of eggs and young needed to maintain normal numbers. The quercus bird which the species disappeared when its breeding habits were broken up illustrates the danger of the effect an adaptation to particular conditions, but with any considerable change the species were exterminated.

The Quercus Pigeon normally lays two eggs and there is a very widespread belief, even among pigeon fanciers,

that there are invariably male and female. It would be useless on the face of it to determine, after considerable observation, come to the conclusion that "the first egg is smaller and is a male, the second is larger and usually a female, while as the second advances the smaller ones also are female-producers." The whole matter has lately been carefully studied by the French zoologists, Gaimard, and by Esch and Rickardsch (1911) in this country. The last two, working together, made a long series of careful investigations as to the time of laying each egg, the duration of incubation, the rate of mortality, and hatched materials. They confirmed the results of Gaimard that in the long run there is a slightly larger number of male than of female birds produced, in the ratio of about 1.04 males to 1.00 females. This is a slightly smaller disproportion than occurred by the French workers, who, however, had but 191 birds in all, while the conclusions of the American authors were based on over nine birds. This discrepancy in proportion of the species' offspring is unusual and is found in other animals, though in different ratios. They reported as well a practically equal death rate in both sexes, so that the disproportion is not due to any defect causing the females to die before hatching. In later life, however, the eggs of one and two years, there is however a higher death rate among the females. As to the current belief that the male eggs produce a male and a female young, it was found that there is no basis at all for the view that the first egg is usually a male and the second a female. The entire matter is purely one of chance, for the number of embryos hatching from the first of the two eggs laid is about the same as the relative proportion of the sexes and was actually 1:1.1, or rounded off 1:1:1. The number of chicks

in which the two eggs produced almost even females on two males in about the same as the number in which there was one young of each sex, a result quite in accord with the normal if it were a matter of chance. It would seem, therefore, definitely disproved that the sex of the hatching birds can be controlled by the breeder. The time of hatching averages 21-22 days, but it is interesting to note that if the same season the eggs had contained the bird usually incubated in it, but in varying times, but we are not sure about the days necessary to start at laying, without the strong impulse they are. A pair of hatching fowls was shown to be an egg substituted for their own four days after the hen had hatched in an incubator, indicating that this "factor of sex" exists in other species and disproves the assertion of Koppel, a recent French investigator, that wild birds have no such notion of the time required for their eggs to hatch.

Leggett has pointed out that the number of eggs laid by a given species of birds substantially bears some relation to the normal death rate, so that the bird may maintain its average numbers under the conditions to which, in the long period of its evolution, it has become accustomed. It is not to be supposed that this adjustment is a perfect one, or that it is capable of a quick readjustment in different species if they become exposed to new factors of peril. The subject offers an extremely field for speculation as well as for careful observation of the signs of normal fluctuations of birds.

A recent very able contribution to this subject has been made by Dr. Joseph Chamberlain (1925), who reports the small number of eggs laid by our birds on ground that their

This is a comparatively rare case. Not the average off-season, parents, immatures, adults, juvenes, and adults of the North Pacific, but one found in island groups, and this coming at last a single young. These birds typically were on islands during breeding.

The Pigmy Gull and the Black-bellied Gull usually lay two eggs. The former nests in cliffs of rocks, the latter on shelves of precipitous cliffs. With other gulls, however, these eggs are single and these birds spend winter on shelves of the mainland. On the supposition that the number of eggs laid is on the average sufficient to maintain the population of a given species at a certain normal, the Cornell assumes that in the case of the Black-bellied Gull (which resembles our Lark's Gull) the single egg hatched increases the total population of Pinnis by just as the beginning of the breeding season—this of course if all the birds pair and all birds their young. The first, the critical condition is depletion here, since not all the birds are necessarily paired, not perhaps in all the young hatch. Thus each two birds become three, and the number of individuals in relation to the normal. But by the following spring the population is presumably back again to its former normal average number, so that the mortality for the year nearly equals the annual hatching but is distributed over the entire colony, old and young. This age distribution of these birds that usually do moult an interesting thing to study, and it may be that, by breeding on islands and even a series of years in particular breeding colonies, we may gradually arrive at positive knowledge. It may be said parenthetically that among a flock of some pigeons kept for experimental study it was found that there was a high

mortality of birds were during the first year or three years of their adult life, and this was especially high in females between the ages of one and two years.

But to return to the comparison of sea birds and land birds. Dr. Townsend compares the assumed mortality of the United States consisting of the total population at birth-time due to the course of a year with that in the land birds. The thing is curious, as an instance, lets say four eggs and relations on average raise female, so that the pair of long spurs raise fifteen, no birds if all birds. By the following spring eight of them will have died if the population is to return to its normal number. Again it may not be right at the young that die, but perhaps both parents and the young, at some other institution. As all events, the mortality would be, at these assumptions, forty percent of 25% of the total population at the close of hatching. The entire number of sea birds we have birds of, but they were certainly fewer than those of land birds. Exceptional conditions or catastrophes during heavy storms there must be, but the conclusion is doubtless correct that in general the sea has a lot more than the land. Another way which will tell you.

There is another factor that may come in, however, that does not seem to have been considered in the accounting. For in the case of many birds that lay one or two eggs and are then able to maintain a normal population, there is not only the fact of a relatively low mortality on account of the nature of their habits, but it is possible, it was likely, that their natural sense of life is longer, so that if a pair of land birds and of sea birds lived out their normal number of years the latter would not only count but a longer time as part of the population, but would be able to breed even a

larger sum of years, and in this way partly make up for the lesser number of their eggs.

But paradox there is in the length of days in a bird's life are not so easily observed. This is one of the matters on which much light may be thrown by banding birds, especially those banded on nestlings. It will be interesting, however, to notice briefly some of the facts already known as to the eggs obtained by different birds. There are gleaned from two sources of unpaired values; first, from observations on wild individuals that have been marked or are others, and secondly, second, from observations of captive birds kept in zoological gardens or in pens. Observations on birds living naturally in the open are the only ones that really indicate the normal term of life under usual conditions. It seems to many naturalists that few animals ever die a "natural" death, they are so constantly exposed to dangers from other animals that prey upon them, or such as frost storms, times of cold, hunger, drought, or other accidents of Nature. As this objection would seem that birds kept in a zoological park, where food and shelter are regularly provided, would be more favorably placed for living out the natural period of existence. But to this it must be replied that captivity is very likely to upset the natural processes of the body, and disease is much more apt to seize the captive. Perhaps, however, the dangers of the free life are counterbalanced more or less by the luxury of food, so that the (compensative) value of the figure is nearly the same. But this remains to be proved.

(3) The first good case relating to wild birds, one of the best known is that of the Herring Gull "Black," which for many years returns again regularly to the Roanoke Bird Sanctuary all our eyes. It appeared usually in October

just left its shell, and though none enough to come to the door to feed it never could be handled. Its identity seemed well established by its familiar behavior, though it was not otherwise marked. There are records of captive birds living for 20 and 25 years.

An instance of a Black-headed Gull is reported by Thompson. It was taken from the nest in the Forest House and passed to one of the parents, given its liberty at all times. It became so tame that it remained from its owner's hand, but was more wary of the other members of the house. Eventually it caught a mouse and the girl chose a nesting place on a shelf of the island. For many years this bird imitated the parent's house for food, going higher from the nest, but the male never became infatuated. This bird was still living, sometimes years from its birth, according to Thompson, who had personally visited the home. In captivity this species has been kept for 20 years.

There have been known to live long periods in domestic captivity one in St. James Park, London, now known to be at least twenty years old, and a European House sparrow 20 years.

A Chipping Sparrow, identified by its having lost a foot of one leg, as well as by its great familiarity, nested for three successive years in Thompson's house, and was later identified by its loss of the claw from a middle toe some few days prior to a landing in Virginia. Another Chipping Sparrow has been taken in Chicago over as long a period. Many cases of Robins identified by some individuals particularly have been reported as returning after a series of years to the same place, but usually for periods of about three or four years. A captive Robin has been known to live ten years.

From records of birds in captivity, several instances have been recorded (see Mitchell, 1911) from which it has not the longest-lived species are the following:

Barn: 32 individuals.

Red-breasted Cuckoo: 22 and 30 years. There is a record of an American Parrot reaching 100 years, and a King Parrot 22 years.

Blue: 22 1/2 and 33 1/2 years.

Cuckoo: 22 years.

Eagle of several species: 15, 20 years.

Bluebird: 22 years.

Collared Dove: 20 to 25 years.

A good many of the smaller birds will live from 15 to 20 years. My friend records a male Cardinal kept by his grandmother for 11 years. The white-bellied nighthawk several years before its death, still finally is looked upon as a mere female. Another was an olive-cybe, grown old in captivity. The same author knew of a Rose-breasted Grosbeak that lived 18 years in confinement. The English Song Sparrow lived 18 years and finally turned quite blue, and a similar probability is known in case of captive Robins (Johnston of Massachusetts has written much on the fact that the European Blackbird is really only a blue thrush, related to our Robin's). Comparison of these or four years or thereabout the known cases of wild Robins like 15 years in the London Zoo is much greater, and despite the lack of specific knowledge I am inclined to regard it probable that the above smaller birds a natural term of 20 years in their life is not a maximum, though under the present conditions of captivity rarely reach as long a life is possible. Blackmer has recognized such a distinction and names the

average longevity in the wild, "quartz" longevity, is the standard to which he equates, where the bird can with good care reach the average human period until the health conditions become dire. This he calls the "potential" longevity.

There is one short-coming to all and one relatively short-lived in comparison. Two years is a long time for them, though they have been known to reach that or six times that in certain cases. However such eagles are generally large birds, and white ducks and geese are natural perennials. The gullinaceous birds, I think, pheasants, geese's are lower in relative viability, ranging in about six years, the Chinese feline under six.

As is clearly there seems to be no correlation between size and potential longevity. The Chinese does not appear to show as a pattern. There seems some support that the theory advanced by Huxford that those birds having short lifespans tend to be long-lived, but since there are also many long-liveds, are not retained so long and short in this class for preservation by humans. There does, however, seem to be some ground for believing that within a group of related birds in the herds, or the eagles, the bulk of the population, the longer specimens longer, but this is not universal. As the study of individual birds by means of banding continues, we shall eventually require the parent and current data on this subject.

Some recent massive studies of eggs show that the weight of the newly hatched young averages about two-thirds that of the fertilized egg. There is thus a loss of nearly a third the original weight, and this is due partly to evaporation and partly to chemical changes of the yolk and albumen, instead of growth, which is part of the normal

food goes off in waste. For the shell of an egg is porous and allows a certain amount of passage to gases.

There is an interesting relation between the weight of the yolk or yolk substance just at the egg and the condition of the young on hatching. It is found that in those birds where young are well feathered with down and have the eyes almost as soon as they hatch, the yolk makes from 12 to 25% (14 to 15) of the weight of the egg, while in those that spend a considerable time as nestlings, the yolk is proportionally smaller, only 2 to 12% (7 to 10) of the egg's weight. The result is that those "nest-leaves" or large-yolked birds are much better developed at hatching, from having a larger store of food to grow on, while the birds with little yolk are proportionally less advanced. Such young birds, that at hatching are almost or even motionless and able to defend themselves, are called "precocial." They include the warblers, the larks, thrushes, larks, jays, robins, birds, crows, ducks, geese, quails, and loons. Those in which the undeveloped eggs the yolk is smaller (large, from 10 to 15 the weight of the egg, and the young are still as food for themselves on hatching, are are probably only in beginning that this "precocial" condition is the primitive one and that it has gradually been lost in those that have smaller yolk and whose young hatch in a less-developed condition as nestlings. The obvious advantage of this latter process is that the eggs hatch sooner and the parents are not obliged to incubate for as long a time as the other kind the mortality of the young is probably greater and the time of feeding them increased. This nesting or helpless condition of the young is spoken of as "altricial" (immature) and is exemplified in the grackles, crows, robins, jays, and other birds, loons and ducks among the water-

food and houses in all seasons, with birds, people, and everywhere, and everywhere. It is not necessarily a sign of relationship to be at one or the other class, but usually marks the degree of conservatism reached by different groups of birds, from the long incubation period.

For some of the incubation periods are really long. That of the chicken is said to be nine weeks. For the duck it is 21 to 28 days (nearly two months); for the Coot many two months, and for the Grebe a half-year almost in water. One of the large railbirds incubates 30 days. For most ducks this period is, from about three weeks up to nearly as 44 days, while shorebirds take about twice time in time (the quail, for 20-25 days). Compared with that of the "chicken" or the English sparrow, 14 days, one of the shortest.

It is believed that a bird must derive considerable satisfaction from a long period of incubation, and particularly such a one as the Grebe which in some cases at least is said not to have laid even for the whole period. One cannot but think, however, that for an entire species it must become gradually dull, and that the shortest period of the more advanced groups is an expression of their greater conservatism.

Now.....The care of birds and the manner of their construction have not been so carefully studied as they deserve, and there is much yet to be learned as to the steps leading in the development of many complex structures concerned with nest building. In attempting to understand something of their various habits, it is natural to use all those steps not in construction that will serve to make of eggs and birds in the nest of their eggs. We know that most birds lay their eggs singly among dry twigs or slightly buried in loose earth. Further they stick eggs in a hole covered

for the purpose. There is no such thing as parental co-operation, but the young are hatched and hatch and make their way alone, reminding us of the "parental" birds. But the alligators and crocodiles seem to show slightly more interest in their children. They prepare nesting mounds in which the eggs are laid all together. The Florida alligator builds a mound of mud and grass. Heron is all mud, and often having the eggs in the water, covers them with mud, mud and grass. The male seems to take no part in all this, but the female stops about mid-July and goes to attack persons disturbing the nest, though this seems to her a little tedious. When the eggs are about to hatch, it is said on good authority that the young can be distinctly heard squawking inside the eggs (and this is true also of some of the water-fowls). The maternal parent then opens the mound and sends in the volume of the young.

Typical nesting birds (a parallel to those that indicate of nesting) are naturally rare in the groups of birds considered the least advanced of those now living and different is birds as similar among the *Alcedinidae*, or *corollae* birds. The large, of *Amazilia* and some of the *Flam* birds, that is seems too good to be true. For this reason perhaps some ornithologists have supposed the birds of this kind to not a survival of primitive methods, but instead a degenerate process on the part of birds that once knew better. He does as it were, these species birds, which are distinctly related to Florida, usually together a long long of long, mud, and other materials, lay their eggs in the midst of it, cover them, and leave them to hatch to the nest but not require outside of the nest. It seems natural enough of this process in captivity appeared in the life. Commonly

the young birds and either make their nest as it was said to be constructed by the male birds, who assume the care of the incubation. Several have been lay their eggs in one of these traps, and it is recorded that a very large number were seen to go there around. Here there is at least the method of the alligator and is certainly more the representative of a primitive one among birds. It is said that the temperature within the nest varies 10° - 15° F. Among some of these *Megascopus* & others, dependent on female they dig a hole in some loose heap the egg, and have it in fact, when the moment of hatching. It is most interesting to find the same habit in a bird related to the phalarope Black-backed Gull of the river banks of North Africa, the bird that runs about among the drying cereals and even picks food from between their feet. This bird buries its eggs in the sand, and they hatch in its warmth. Such a method is suitable for eggs requiring a moderate incubation time is considerable period. It would not do for the more ardent species that hatch in shorter time at higher temperatures. It may therefore be supposed that these methods, if not actually relics of an ancient habit more largely abandoned, are at least similar to those used by the primitive ancestors of our present-day birds. Even of the same thing are perhaps the habit of goshawk of covering their eggs with the sharp ends of their feet when they have it in a hedge or dense thicket, and the similar habit of ducks in covering the eggs with the down of the nest lining as like as possible. Possibly the habit of some birds of bringing grass leaves as part of the nest lining is a remembrance from a stage when they fastened eggs to the end of grass and branching leaves.

It is difficult to see other earlier steps in the development of parental care among living birds, for most of them seem to have gone far beyond such primitive steps. Among the hundred species, including the various waterfowl, there are, however, very primitive attempts at actual incubation. Some birds do not, but merely lay their one or two eggs on the bare ground and incubate them there. The penguin of the Antarctic makes perhaps less a model for lack of anything else, and one species, the Emperor Penguin, being where there is, even less providing nest material, actually builds the single egg on the back of its feet and covers it with a loose fold of body skin. Here it hatches, and so in the baby world.

One suggests that the desire to withdraw into a safe shelter during the period of incubation may be the next stage, and induces the bird to seek a cavity, a hollow tree, or a protected burrow in the ground. Thus, the first, it is not a long step to the digging and enlarging of a cavity or burrow, and finally to the actual construction of a burrow; such steps as this are found for example among the Plover and Pigeon Chalcididae that enlarge or hollow out burrows, or seek deep holes among or under rocks. Proceeds in the same. Dr. R. C. Murphy has pointed out that among ant-eater birds, the larger species nest on and the smaller in the ground, partly no doubt because the larger birds are strong enough to defend their nests against such robbers and the surrounding *Ant-eater* birds, while the smaller birds, which they ought doubtless to be taken mostly by mistake, are in danger from these larger birds.

It seems reasonable to suppose that with most of the hundred species, birds have taken the young out side to run about shortly after hatching, the important factor is the develop-

most of the nest-building birds is willing to risk parents sharing the long process of incubation. This is accomplished among many birds that nest on the ground, either by choosing inaccessible places such as ledges or island cliffs or by making a tunnel or cavity. Among land-birds, the cavity made is often obtained by the development of existing passages as in gophers, quail, woodcock, shorebirds, night-hawks, and others. There are of course birds whose nests are built perhaps more conventionally, as warblers, blue-throats, orioles, wrens. They mark out and dig their nests from scratch by themselves, being aggressive. In all these species the nest construction is not elaborate, often there is none at all, or at most a few straws and bits of rubbish brought from elsewhere at hand. Again, however, as in many ducks, a thick layer of down is made immediately previous. This is placed down the length of the sitting bowl, and I have suggested that it may be a relief to the parent, as a constant irritant to the nest of the eggs against its breast, rather than a thoughtful provision for keeping them warm.

An extraordinary protective hollow is thus found in the hornbill family of the tropics, in which the male bird actually picks up the material with his own beak in a hollow box, leaving only a hole for the protrusion of the female's beak, but while she is thus immobilized he regularly visits her.

The sandpiper and plovers as a group make a simple nest on the ground that may vary from a hole-depression to a grassed hollow. There is, however, an exception to this rule in our ordinary sandpiper and its near relatives in the Old World, the Green Sandpiper, both of which utilize the old nests of other birds built in trees. Sometimes the Green Sandpiper will use a squirrel's nest, or a mouse nest,

birds. This habit, though long known in the Old World, was not discovered in our country (excepted for recent years). It is an exception to the rule and may have been a habit developed in comparatively late geological times. This is shown a dozen times over in the other species birds considered, in most in some. It is this habit of over-shooting, or at least of eating others ground, that has become characteristic of many of the so-called "higher" groups of birds, and in connection with this helps to show that the study of birds young has perhaps been responsible for the extraordinary development of new architecture.

If we had a suggestion of the interesting habit in several of the water-fowl, that even in it some of the birds naturally where their ground nests are in danger from rising waters or ground-living mammals may inspire. Thus the House Wren of Florida, when their nests have been destroyed by natural causes, have occasionally been so building nests over in the mangroves. Heron-like some other birds build in trees on island waters where the isolation of small islands is not available. Cormorants will usually build in trees in the tropics, making strong, compact nests of twigs. Young penguins, as well as young pelicans, are suspicious of hunting so that it would perhaps be expected that they should have some sort of nest in water. In their early days, herons have nests over very close where they appear.

It is not until we come to the herons, ducks, and pigeons that we have the scope of the more primitive water-birds and come to those that regularly construct nests of some substance in water. It is then that herons often make nests on the ground in regions where there is no water, and some of the pigeons usually are ground-dwelling, but we shall

manifestly find that no single group of birds there will be exceptions to any general rule. Hawks make very solid nests and the Plumbeous-backed Vulture, a small bird about the size of the Hairy Woodpecker, makes a huge affair in the fork of a tree, resembling two bushels of wheat with an entrance on the side.

Including the numerous more groups of birds such as woodpeckers and buntings, that usually nest under the bark, and such groups as robins, kinglets, and tanagers, that usually all dig holes in banks, the remaining birds include most of the more progressive species, such as hawks, buzzards, warblers, thrushes, swallows, and cuckoo-like birds. We think in many cases some of these birds have gone away in seeking other kinds of cavities. Thus among woodpeckers, though the great one is the usual type, as with Hairywood and Wood Pecker, there are the usual exceptions, for the least of them has holes in holes in trees and the Flicker makes a most characteristic set of holes or "under independent" nests. Among swallows there are those that nest in holes and at their own making, as the Tree Swallow, where they dig their burrows, about in the side of a sand bank or in level ground, while the Cliff Swallow constructs a series of clay pillars and lives in with chambers and soil's gaps. The Red-winged Blackbird belongs to a warbling family—the Chickadee and Cowbird are its relatives,—and it is perhaps due to previous ages of the-birding that the nest among small things is so deeply sought. Among sparrows and song-sparrows there are many that have perhaps returned to ground-nesting in a similar way, as the Junco and White-throat among the former, the Oriole and Goldfinch among the latter.

Most interesting of all is the development of the solid



Three small, light-colored, rounded objects, possibly eggs or small stones, resting on a dark, textured surface.

On the 12th of March, 1900,

the first of the season's snow fell in the morning, and the snow continued to fall until the 15th, when it ceased to fall. The snow was very deep, and the ground was covered with a thick layer of it.

together than brought down colonial and finally commenced nesting. Among the South American birds was Yellow Cuckoo or Campata, a single nest with seven contents, many of them long hanging nests, or closely placed as to be almost if not quite in contact. The African warblers have joined this list. More species nest in colonies, hundreds of birds placing their hanging nests along the rough branches of a single stout tree. In nesting time the constant jargon of their notes is an extraordinary sound. It can be imagined that continued screaming would bring the nests into contact so that under branches would be covered, and we do actually find in South Africa a species that makes a vast movement of water in some dense forest, while nesting, continuously moving out to the little passages along which the birds move. A species of parrot in Argentina has gone nearly as far, building great temporary nests in which, however, each chamber is separate, and to which more are added till the nests weigh a quarter of a ton or more, and are eventually full of the nest weights.

I have listed one more of the species to which we now refer, and the more specialized birds which, including both small helpful young birds to have been fed in constant attendance over the building the eggs securely and afterwards in safe positions for the young during their first steps. It seems very interesting to note by illustration (see p. 1) of nest structure in comparison of many further species. The specially emphatic idea that is first purpose of the bird in making a nest is with the idea of building a rampart about the eggs. It seems to me further that the primitive builders confined in passages are obliged to do, and that long-nesting birds have been largely responsible for the development of the more complex structures.

CHAPTER III.

[THE FISHING] SCENE OF SCENE

It TAKES a long while to get an angler (he is plain as money) that gets the thing in the capture of some other plant or animal, and is thereby saved the need for itself undertaking this labor. But there are many degrees of parasitism, ranging from mere highway robbery to actual extermination of the host species. Many birds play the high-squawking rapping degree. I have seen Herring Gulls do so behind a fish-bait. Doves will, by their more or less quiet, precise and rapid stroke of the beak, snatch the bait from the fish and carry away. The gulls stand near the spot where the fish catches the worm, but evidently lose their plunder. On the Pacific coast, Fisher calls it waste, by Brown Pelicans fishing at Santa Monica. The birds had been attracted by a school of small fish, among which there were, coming in the surface with their heads. "A horde of twenty gulls were following, seized in success on every pelican that came. The last one stopped and came up with the bait, but was surrounded by the gulls, each is waiting to get a bite in the pelican's fish-bag." Another observer, Clifford, has seen Rocky Terns dashing valiantly about a pelican while it was fishing, and when diving on the long, gathering bird's head while it swallowed the bait. The tales about the voracious pelicans were proved to be unwarranted, nor did he ever see the Noddies get any fish. Even the Laughing Gull, it was said, will sometimes go by its host's head

leaving fish for their young, that relatively few may pass the parasites and much their time without being allowed to drop their loads for the benefit of the gulls instead of their own young. This condition, however, must be unusual, though it has been observed in the breeding colonies of shore birds at Washington Island. The Bald Eagle, too, is often a harasser. Its love for fish frequently prompts it to pursue a Fish Hawk when a successful dive, and when the latter at length drops his prey, the eagle darts like an arrow after the falling fish and catches it before it reaches the water. The eagle, however, can catch its own fish and will feed on dead fish washed up on the shore. It is not difficult to imagine that some of the poorest parasites with colonies would become an established habit, and, as is one of the features of *Halictus* Gulls, it is a characteristic trait of the bird.

In the region near Washington Island *Marek* Bird is well known for its peculiar habits. For although it can and does dive much for itself, diving down in the water to pick something from the surface, or even bringing up a large fish to eat, it is nevertheless a constant tormentor of the species of gulls with which it is associated in the summer part of the globe. St. Adams Bay contains a cove on Adams Island where a nesting colony of the common Brown Booby was the cause of attraction for numbers of *Marek* Birds. These were usually to be seen circling watchfully on the tops of trees or perching the air high overhead watching the comings and goings of the birds. Frequently one or more would come in, bringing fish for their young. At once a half-dozen of the *Marek* Birds would leave their perch, would fall and to engage the remaining fish. "Thumping down quickly from

every side, bathing in cold state springs, snapping at it with their long bills, circling, diving now above, now below, now below it," the numerous plovers on confused their vision when it has done its duty which then the water would sweep upon, one of them sweeping it and sweeping it off as it could reach the water. Just how many young plovers started to death over words of the "Moose" story. Bland's solitary has not been definitely estimated, but no flock or aggregation has been seen to hold upon them. That does this alleged preference become no more established, but it has been seen to search up and fly away with a swelling of her own species where parent had been disappointed of the nest.

This habit of moving upon the hillside among while the parents are completely off guard is maintained by experience in case of the big Red-tailed Hawk, a selection of the Jaegers or Golden Eagle. In Great Pond lands these birds have the penguin colonies, drawing eggs or chicks that are not necessarily left unattended. In great is the manner from their powerful birds that the penguins (Larrea Pinguis) have developed an interesting habit to tell them. For the purpose of food supplies the growing young of a colony is large and requires the efforts of a large part of the adults but its supply. Consequently a common method has been evolved whereby the young birds are turned into some groups of their own kind, protected by a few old birds who stand guard against the adults while the other parents are engaged in feeding for the younger population. The evidence holds of the other more than to start upon them, alone, but "Where are they although now adults are always hatched, and many that one of them is even raised, because one of the pair is almost sure to be gathered up by some other than nesting one. This must be an unusual condi-

them and seems to emphasize the fierce competition for food and food in these inhospitable regions. It is interesting to see that in exactly all those cases in which white birds of one species kill others of their kind, the "time of execution" is day.

Among susceptible birds, however, some of the chicks are frequently appropriated just as the water birds brought up by diving Gulls as we have noted for themselves the common nests of Fish-eaters. It seems probable, however, from a study of the stomach contents that they do it more interested in the insects which the Gulls are especially fond of than in the young birds and adults so that there is seldom any antagonism displayed.

Another way in which one species of bird becomes parasitic upon another is in the manner of using the nest of some second species. This frequently an old squirrel's or mouse's nest is fitted out by one and by two species now, or the first species, in a desirable nesting site may be driven out and their home appropriated by a more aggressive species, but several possibilities readily occur to me some of them in which one species lays its eggs in the nest of a second and leaves them to be hatched and the young cared for by the foster parent. This habit has been independently acquired in several groups of birds particularly by some of the cuckoos and some warblers. In a slight degree we find it among ducks also. While many ducks are nesting in the same marsh, the female-mothers-become somewhat careless in depositing their eggs, and others lay in each other's nests. It is common to find a single nest containing more eggs than one bird usually lays; as if two chicks of the same species had deposited their eggs in a common nest. Many such instances are narrated by Dr. J. C. Phillips in his work on this

group. There were *Melospiza* which ran eggs in an average set, as many as 14 have been found in a nest, and the same is typical of the *Cyanoceryx* Tird and others. There were also nesting eggs of the *Melospiza* in nests of *Cyanoceryx* and *Redpolls*. There, containing eggs of both *Melospiza* and *Tird* are also recorded. The *Redpoll* is sometimes common in this region. There were also nesting its eggs in nests of *Reddy* (Red) and *Cyanoceryx*, in one case the latter species including the combined birds. He notes that that both *Redpoll* and *Cyanoceryx* seem to have the peculiar habit of building nests in which both species deposit eggs but do not incubate them. One such nest found in *Redpoll* was contained in eggs apparently belonging to *Redpoll*, *Cyanoceryx*, and *Melospiza*. Another found in California contained *Melospiza* as eggs belonging to 1, 2, or 3 of one egg and 14 of another. The *Loxia* group (Red) sometimes have a few eggs in nests of other birds. There have been an egg of the species in a *Redpoll's* nest and another in the nest of a *White-winged* (Heron). It is noteworthy that all these are mixed-nesting birds, and we may suppose that the birds which are forced to deposit their eggs where as a chance from their own nests, or that the chance right of a nest of eggs of some other bird will be a chance to cause the owner to gather upon them and add to the set. It is noteworthy that the subsequent history of these multiple of eggs have not been followed, as we do know that one female bird alone part in bringing up the mixed brood.

In the case of species that nest in one another, the number of similar nesting sites frequently induces comparison. Thus in *Redpoll* where the *Redpoll* *Melospiza* and the *Redpoll* *Reddy* (Heron) nest together, their following habits alone leads to two females trying to use the same nesting

The Wood Duck *Harelda* seems less conspicuous with these species. One writer mentions finding in a single desirable hole no less than 50 eggs of the Wood Duck and five of the Merganser. The hollow of the tree was not very large and the eggs were several hours deep!

It must be said, however, that some of these cases quite belie the conditions of parasitism, but each species certainly makes its own nest and raises its own brood. The above seems to be degree of frequency with which the different cases lay in other shells' nests, the Redhead being perhaps the most abundant. It is easy to see, however, that among hole-nesting species, where proper nest sites were few and birds more numerous, a parasite's habit might be developed simply through one species being prevented from regularly occupying its chosen nest.

There is a female American duck, however, in which a case of actual parasitism seems to have been noticed. This is the Black-headed Duck (*Mergamallus*), a species found in the southern parts of western North America, but one that appears to be nowhere common, or at least not very thickly so (probably known about 10). A recent writer, however, has published some notes on its habits in Argentina where modern previous suppositions that this duck sometimes lays its eggs in the nests of other marsh-nesting birds, including the Ring-billed Gull, the Limpkin, the Cinnamon Gull, Coot, etc., a large Mall, the Spangled Heron, and even a species of *Rea* (*Chloris*). It is difficult to imagine how the young ducklings are reared for by such diverse parents, but perhaps they can take care of themselves themselves. Possibly, too, the reported parity of the species may have some relation to the parasite habit and the prevalence of this mode of hole-nesting.

Among landbirds the habit of laying eggs in other birds' nests and leaving them to the care of strange parents, has been independently developed in several unrelated groups.

In the Laniidae, the family to which our robin and blackbirds belong, provision is well known in our common crowbird, as well as in some of the thrush-throated species. That species lays its eggs in the nests of others, usually smaller, birds, apparently only one in any particular nest, though some of the nests in which one or three eggs have been found in a nest were by the beak of a single bird, perhaps, however, of more. The young, confined in hatching specially contrived and generally cramped out for sustenance until about hatching, is provisioned perhaps much more liberally by his larger sire and consequently needs less food and space than the rightful young. By evidently eliminating some provision he is thus able to escape the notice others of the foster parents and to provide by a more plentiful food supply and spacious growth to maturity. It is strange that we know so completely known of the methods whereby the broods created under the nests of fast sleepers and possessors but one egg. And not ignorant of the way by which the grown young require the parent birds to equally grow. Wilson records that the young of a thrush-throated warbler seemed quite indifferent to the warning calls of its foster parents, that would at once have saved their own young in such situations in the nest. Even after the young created has left the nest, it is still, he says, capable of some, and more than once has he seen one captured off from its own species' nests by a hawk when it might have escaped had it heeded the warning of its foster parents.

Indeed in the pelicans usually named in regard to the conduct of the Argentine Republic. The Marquis of



A THREE-FOURTHS FULL-SCALE MODEL OF THE PROPOSED
 DESIGN
 COURTESY OF STEVE HARRISON, JR.

Embick (*Microgaster debilis*) is said to be distinguished by another species, the hatching Embick, that the three-winged males lay their eggs and perform the parental duties in a proper manner. A third species is again possible. Apparently the males lay upon their the females, although Krom's statement that it is not so is very well founded. Nevertheless, this may have a bearing on the origin of the latter. Hübner hoped that the French description would prove eggs in old females were as well as old males lay just up to their for the purpose, showing a lack of discrimination and slight approximation to the European species. He believes further that the same female will lay several eggs in the same way, and he has known several females to lay in a single nest as that incubation was impossible for the very number of the eggs. Thus he was aware of the Ichneumonid *Phaenocarpa*, which is usually an egg, only as were the *Phaenocarpa*, but as a new condition. He frequently in this species provided that it is followed a large percentage of females were as described as a result of the incubation period by the parasite. Moreover, it is said by Hübner that both male and female embryos develop more of the eggs in the same way, by breaking or destroying them.

In this same family (Embick), possible further have been described one of the French description which however as Hübner (*Embick*). According to Embick, one species is common (Embick), equivalent to the egg in the nest of another (Embick) of the same genus (*Embick*), while further south, of the French, it is not known to the species which related to the of the same genus, as the *Embick* (*Embick*).

It is here to found the parallel family of three species

then found the neighborhood of white-throats and agreed to lead people to them for the purpose of obtaining their share of nests and eggs. Most of the species are known species that grow with white-throats, and even so far nearly all of them possible, although much is yet to be learned about them. Sparrmann's Honey-bird of South Africa has been seen to have the nest of a White-throated Swallow, which on examination was found to contain two small white eggs of the swallow and a third larger and less, presumably of the honey-guide. It cannot be said, that White-throated Honey-bird of South Africa, is known today to eggs in the nests of the Black-collared Warbler, and of the Orange-collared Warbler. Black and White white are known of a honey-guide of this species, being pursued by a pair of Oranges in whose nest there were seen three eggs of the Orange and the newly hatched nest of the honey-guide. With a third species, the Lesser Honey-bird, has also been shown to be possible. It is not known that its eggs have been found in nests of the Olive Whistler and of the Red Warbler; and it is said that two other species of honey are also thus associated, all therefore following species. Black and White white an incident in which the honey-guide was at least partially involved. The bird first shows to the nest-hole of a hole, but was opposed by the male, whose efforts were promptly corrected by the female's side such that the intruder was finally cut and chased away by the female bird, chattering and fighting the while. In about five minutes the honey-guide appeared, however, and the same nest was entered. This continued to proceed as far when all three birds were done. The honey-guide was found to have an egg ready to be laid, indeed actually proceeding



NEST OF THE HOUSE SPARROW (SPP.) BUILT IN THE
 CRACK OF A WALL IN THE CITY OF NEW YORK
 (Courtesy of the American Museum of Natural History)

from the nest, while the hatched nest contained two fresh eggs. In another case a pair of the same species of hawks was found brooding a young Lesser Honey Cuckoo nearly hatched, besides in a similar nest-hole of which but one the male occupied, having no doubt eliminated the rival of the young.

It is noteworthy that the eggs of these honey-guides are white and those of the birds mentioned as parasitised by them are also white, while, as we shall see, with the cuckoo the eggs are speckled as are those also of its host species. That is, the eggs of the intruder have a general resemblance to those of its host, though whether this is enough to decide the latter's acceptance will.

It is among the cuckoos of the Old World that the parasite habit is best known, and here it is found in several of the species. Apparently the American cuckoos have not developed the habit in any extent, though there are several instances wherein a cuckoo's egg has been found in company with of some other species. In the Philippines there is a cuckoo called the Great Cuckoo which is parasitic upon a large brooding heron in the lagoon (Marian). Sharpe points out that in this cuckoo, contrary to the usual rule, the young bird in its parental plumage is not colored like the adult female (that is, black above and rufous or brown below) but is exactly black like the adult male of its species and in this stage is described under the Black Monks, its foster parents. Sharpe believes that this distinctly helps it the more easily to pass as the young of the Monks by which it is then reared. The two cuckoos of the genus *Coccyz* seem to be generally parasitic, and are widely distributed in the Old World. A third cuckoo species (*Coccyz palmarum*) is parasitic on what the Black-gull and the Black Oystercatcher. The last species is known

to place its eggs in nests of the Wren-watcher (Pipit) has shown the nest of this species is very small and almost empty. It is apparently a physical impossibility for the wren to lay its egg in the nest. It is therefore believed that the hole is not the ground nest that wren is in but built in the nest selected. Some of the African Cuckoo Cuckoo-Like genus (*Coccyzus*) are also parasites and especially so when an egg from a nest is replaced it with one of their own. One of these birds, Wilson's Cuckoo, is known to have laid in a Kingfisher's nest, and another in a Woodpecker's hole. A second species that frequently parasitizes wood birds has usually been twice shot in the act of carrying its own egg in its bill to place in the nest of the host species. It should genus of cuckoo (*Coccyzus*), larger birds about 12 inches long, has at least four species in North America, all of which are parasites, some on the others, while two Indian species parasitize Bunting Sparrows, laying like eggs like those of these latter. The Spurred Cuckoo (*Coccyzus*), however, builds its own nest.

The European Cuckoo—the Cuckoo of the poets and of children's tales—is more common and has been more carefully studied. The eggs of this bird are deposited in the nests of a number of species of which, however, the Meadow Lark, Hedge Sparrow, and Field Wren are among the most frequent. It is believed that individual Cuckoos have usually lay their eggs in the nests of a particular species, and that their offspring is more parasitic than some species that never take their own parents. Thus certain Cuckoos lay their eggs in nests of the Hedge Sparrow, and its young later, from constant association with Hedge Sparrows in spots, may in its turn lay eggs in nests of this species. Sharpe once recorded a case of a young Cuckoo that was kept

after-though the nests in the Tullaght Gardens at Carr. ick, and by the following spring were so all covered as usual. But. At that time a number of British species were found. Several, including Hedges Sparrows when at once the Chaffins, "which had lived for weeks in the Gardens, and was particularly able to feed itself. Although there is the little Hedges Sparrows, and began with open mouth to devour in the lot." It is remarkable that Chaffins must have been raised by Hedges Sparrows, and had recognized the former species, as later, being out of season. The eggs of the Chaffins are relatively small for the size of the bird as they are not greatly rich in yolk, and when placed with those of the smaller species. They were greatly in color and apparently each individual Chaffin has a more or less identical style of egg, so that the eggs of a single bird are more or less the same in pattern of markings, or in ground color. A careful study, "The Chaffin's House," recently made by a British ornithologist, Edgar Clancy, has confirmed and extended many previous observations on this bird. Clancy kept watch of a pair of birds where several pairs of Hedges Sparrows lived, a species commonly persecuted by the Chaffins in his neighborhood. His method was to observe all the nests of the Pige in this area, and then black or in other ways make continuous observations on them and on the Chaffins that frequented the nestbox. He found by direct watching that a female Chaffin usually anticipates her as possible a given time, keeping out other females. Such a bird he called a dominant Chaffin, but in some instances there were Chaffins that seemed to have less nearly complete control over their chosen nestbox. Such Chaffins were described further from which they can occasionally visit over their domain, and actually spend much time travelling

the watchful operations of their intended victims. In this way the Cuckoo discovers the situation of the nests since it is adverse of their readiness, and even then does it not rise to the temptation to be heard (then there usually). Chance believes that this watching of her drops in the nest-building process is almost as indicated in the fact that the egg is ready for laying (when) but at one drop (usually) the temptation that seems certainly very probable. It also interests the Cuckoo in a feeling of proprietorship that results in her driving off other Cuckoos from the territory. She further believes that the number of eggs laid by a single Cuckoo depends in part upon the number of nests available within the principal territory and may be even as many as 12 in a season. There is then a certain number when established between the time when the nest of the victim is to be made and the time when the egg of the Cuckoo is to be laid. Any upsetting of this relation, as for example if the completion of the victim's nest is delayed or stopped, results in the egg being ready for deposition too soon, so that in such emergency cases it is laid in some other nest ready at hand. Chance believes that this accounts for the laying of an occasional egg in a nest other than that of the usual host. These Cuckoos may even be "hatched" some occasionally in the future, for if the intended nest be suspiciously well concealed and difficult to find the Cuckoo may even lay in a domestic nest placed conveniently near. Having learned the hosts of her intended victims, the female Cuckoo lay occasional visits frequently when they are completed and the fresh eggs laid. When all is ready she leaves her observation post, glides softly to the nest, removes one of the eggs in her bill and lays one of her own, presently flying away again. The entire process is silent, and certainly not

in few seconds. A photograph was taken showing the white Cuckoo laying her egg in a Meadow Pipit's nest, while on the same nest holding in her bill an egg of the Pipit's that she had removed to make place for her own. This seems to be the general habit of the bird, but instances are given in which this habit had apparently become exaggerated and two eggs of the host species were removed.

It is well known that the incubating or incubation of a Cuckoo's egg is variable but with a given bird the eggs are fairly even in size and have their own individuality. This fact was in many cases demonstrated by Mr. Chasen in his study of the various layings of the same individual Cuckoo. That the general similarity in pattern of the Cuckoo's egg to that of her victim's may have a bearing on the choice of species parasitized has been further suggested. Chasen quotes the observations of Hagerman who made a number of experiments in interchanging and substituting eggs of several species breeding in North Africa. Some birds showed the great ability to reject the foreignest eggs, while others seemed quite indifferent, and accepted nearly any substitution. Chasen suggests that a possible explanation may be seen, here, in the fact that Cuckoos are mainly parasite upon certain species; that the less discrimination and restraint shown by the hosts, the greater is the chance of the young Cuckoo being hatched and reared by the foster parents.

Among the most interesting notes in this document is an account of the courtship actions of a pair of Cuckoos, the male pursuing the rarely ventured female, and calling all the while. The interesting point was that the female was moving a very or over about six inches long, while the male held her over a minute during this performance. This

act of plucking up nesting material is a common act in the nesting actions of many species that build nests and that thus be reminiscent of the time when *Claytonia* built their own nests.

The origin of the parasite habit may long be obscure. Several lines, however, seem to point suggestively to possible ways of origin. Thus among the more noticeable it will be recalled that many of the birds occasionally lay from two to several eggs in the nest of another species, or that of the same species will frequently lay in the same nest. In some of the latter groups the eggs are laid in nests of hole-nesting species, as woodpeckers and hawks, which have white eggs like those of the parasite species. Of two species of warblers in South America, one is frequently parasite on the other as lays in nests of other birds than those, like itself, a desired egg. The smaller of two Hesperis lays its eggs in nests of a larger Hesperis. There is thus in these pairs a certain closeness of relationship between the parasite bird and some at least of its victims; and there is certain resemblance between their eggs as well as in the style of nest built originally constructed. Now it finds it is well known that in certain species isolation and egg-laying may be induced by proper stimulus. Thus Craig found that *Thryothorus* could be induced to lay eggs in response to several methods of stimulation: he saw that a young female started to incubate, when alone only human companions, responded to the appearance of another member of her kind and male still laid its egg at the usual interval from the beginning of the experiment. There is a very different in their method of laying. With these egg-laying cases of a definite time off year end, as with male birds as the Flicker, the presence

of a nest-egg seems to encourage them to keep on feeding on it to attract a mother whose constant attendance would protect the breeding-birds. It may be that in case of those birds whose eggs serve as stores to be laid provisionally in case of their neighbors, the mere sight of a nest-egg suggests being able even more so as a stimulus inducing them to add to the number. The same suggestion may explain the persistent feeding of an egg by the nest of a different species, or instead of various birds, and these facts habits, perhaps, may possibly have others. The case of the Clarkia seems different, for these clarks are not true relatives of doves. Henslin has suggested that the habit may have started from a habit of "incubation" of eggplants in nest-building" such that the eggs were kept by being below a nest and made the birds' property. The fact that the habit is found in so many species of various forms to prove that it is a trait of various origin, so certain that it had become characteristic of the genus *Clarkia* before the various species of the genus had been washed off from their parent stock. With the warblers, however, the trait is not quite so fixed, for there are some species that still make their own nests. Should these species be considered to prove the same, and the possible species be preserved, we should have a case similar to that of the Clarkia in that the remaining species have which the stock has now developed different this habit.

Still another possible way in which we may imagine the possible habit to have started is shown by the gradual simplification of one of the warblers. The first is a European species, a descendant of birds which, known as the Green Warbler (*Parus olivaceus*). This bird has the remarkable trait of being in the abandoned nests of other

Birds, usually of the European Blackbird and the Yellowthroat. Their nests are found near the shores of ponds in some countries as high as 25 feet from the ground. Here, when found many such nests in common, were to have been the first to publish much about this singular habit. He records one case where he found eggs of the warbler in a Yellowthroat's nest where which the young Yellowthroat had been lost six days before. Sometimes the same bird is used in two successive years. This would say also found the Green Heron's nesting in old half-burned nests of Jays, Wood Peckers, etc. even in a sparrow's nest. The young as soon as hatched jump to the ground and flutter about about them. Eggs are inserted in clusters of seven and of eight eggs in each a nest, instead of the usual four, probably the additional three of two birds, each incubating a variety of desirable ground-bound ones. In this country a similar habit is found in case of the solitary Kingbird whose method of nesting was all years ago unknown and the nesting place a mystery until the discovery of its eggs in an abandoned Robin's nest in Canada. Since then, this bird has been found nesting in Illinois and elsewhere in abandoned nests of the previous year. It seems to select no special choice of nest, among those of Howard Grackles, Brewer's Blackbird, Cedar Waxwing, English Sparrow, Canada Jay, in situations up to one yard above water. A number of nesting birds nested one season in Illinois may have resorted to a variety of kingbirds through a lack of sufficient abandoned nests for their use. In one case in Illinois's nest of the year before had not been found earlier than 1883, but eggs were deposited on the original nest being.

It not support the supposition of a similar habit in such

is spoken as the Country, it is easy to imagine that the first might not discriminate between a newly completed war and one recently abandoned. The result would be that if the invasion held in the new war, its rightful owners would attack the invasion and prevent the repetition of the war, even though they had themselves to bring up the countless soldiers. It is likely, too, that the greater abundance of new than of discarded arms would lower the frequency of such mistakes until the general habit would have become established.

One must therefore be prepared to find that the tests that have appeared in more than one way, and independently in these different groups mentioned.

CHAPTER I

THE STUDY AND HISTORY OF BIRDS

It is a feeling perhaps as peculiar to the human race, as the sense of numbers, as a sense about which the rest of the subhuman creation, and as far as we are aware, our own feelings and desires as other animals that differ greatly from us. It is only in very recent times that we have gradually learned to take a different view of the matter. In our observation of the habits of birds we must therefore be cautious in assuming that they will act just as we would under given circumstances, and in our interpretation of their actions we must ever be on our guard against substituting our own minds for theirs. It is however necessary to use as we may the common and misnaming of birds in order the better to understand how they are affected by the impressions they receive from without and how they respond to these stimuli. The study of bird behavior is a wide and fascinating field. Each species and individual possess its own characteristics, and there is much yet to be learned by careful and critical observation of individual birds. To do this in the natural state, there must be some way of identifying the particular bird, and this difficulty is met by marking them with the numbered bands now so familiar.

In studying the causes of birds great difficulty is met in eliminating possible causes of error. There are always so many other things that might affect the result that we

cannot always be one of our interpretations. This is why tests in the laboratory where the conditions can be controlled are equally necessary to collected observations. Fortunately comparatively few species of birds have been studied under laboratory conditions, but even some birds within our study sometimes give responses to unusual sounds or movements, or surroundings, so that we are not always sure that their actions are deliberate and normal.

Sight.—The sight of several species of birds has been somewhat tested in the laboratory. From field observation there are various observations that in some day-birds sight is fairly keen. The height at which hawks, eagles, and vultures appear to be gazed in their search for food is apparently to be interpreted as a proof that they can see as well as distinguish small objects at considerable distances. Yet there is doubtless great variation among different birds in the keenness of their vision. For example, some of us may have had the experience of seeing cardinals by a clear bank and observing a company of American blue jays to pass a few feet distant without taking notice as they went along, looking as they go. If White Ducks, however, it is of no doubt more discriminating vision that he would spot all long before reaching gunshot range.

Birds' eyes are somewhat different from our own. In most species they are placed at the sides of the head so that instead of looking forward in the same way that the head points, birds often "look their heads," as we say, in order to bring our eyes particularly to bear on something they wish to consider. In our own eyes there is a glint or the retina or cornea carries where the focus is sharpest, called the "yellow spot" or macula of its distinctive color. In many birds it is found that there are two yellow spots,

that is, one of the eyes is at the front corner but looking at the side with one eye, while the other is at the rear corner, the seeing with both eyes something directly ahead. The side position of the eyes gives command at least about fourteen of a circle, meaning of half a circle or hemisphere, as in mammals. Likewise, the eyes of birds are relatively nearer the top of the head so that they can not share them to better advantage than most mammals. Dr. J. C. Phillips has recorded in his observations of some Canadian birds that he believes they have very far and keen sight. For he has often, while concealed in a blind near some decoys, seen them cast an eye whole and well out in a field of wild grass growing high overhead that no human eye could have detected even by the best chance. In the Albatross the eye is so large compared to head that it seems and the bird must surely be able to look behind as well as ahead. Probably the large size of the eye is an adaptation, but doubt as to its bending.

The action of the spread of flying birds, their eyes must have power to adjust their focus quickly, so that we find in birds that there is a special muscle for changing the shape of the lens of the eye by its pull, that at the same time changes the focus. There is a parallel structure in the interior of the eye, called the ciliary from its condition as banded shape, which helps to increase the blood supply of the eye. Another structure is found in a few reptiles, that magnifying some more than others relations between birds and reptiles.

A few species of birds have been tested to see if they can discriminate the difference colors of the spectrum visible to human eyes, and, as may be imagined, the matter is one difficult of satisfactory proof. One species, *hematopus*,

We are therefore that our master used in making observations, from what were probably obvious premises.

The maintenance of birds in lightlessness would seem almost self-evident to be very true, but laboratory proof of this is difficult. I have suggested that it was a defect of this sort that caused birds to come in the morning, as by my clock-jack. While living in Boston and near, I noticed that the House Sparrows, which roosted regularly in a tree near my window, began to roost and start singing at approximately my window before the sun rose. As the days grew longer, and the sun rose earlier, the sparrows came on correspondingly earlier, until on spring days, they were all out long before my own waking time, which was controlled by some quite different clock-jack, though regular enough too. Those of us who have lived in summer near Mississippi have noticed, upon the particular day when they begin their regular attendance about eight have the effect of causing them somewhat earlier, as though their action depended more or less closely upon the degree of lightlessness. The late Homer H. Wright published the results of very numerous observations on the time and relative order in which many of our common birds came in the morning and went at evening during the breeding season, from which it is clear that there is a considerable regularity in these times and that nearly every species has its characteristic place in the schedule. The matter is one of common knowledge, though its careful study is yet to be completed. The evening of the Chantrelle is an excellent example in the morning that people who live in an area the tropics, where winter does not greatly vary in time, make the same

evening equivalent to a doing well. You recall the lines from *Conscience Translated*:

And in the dark were, there with great before
 The Translated—"Open then the Door!
 The house has been made not here to stay
 And, now, do what you mean to do."

Experiments made with small circles, however, in an attempt to see if other factors being equal, they could learn to discriminate between two lights of different intensity, were rather negative, and it was not until one light was made as strong as bright as the other that they seemed to notice a difference. Very likely there are other factors of a mental nature involved.

One intuitive Rabbin seems to be one of the students of the common folk to rise and sing in the morning, but whether it is the change in the intensity of light with the approach of day, or whether when moments of habit are involved, we are as yet unable to say. That the "pale gray light of dawn" may affect Rabbin as that they are prompted to sing, seems likely, and we have often noticed that in devotional hours during the breeding season, the earlier crowing of the day with its accompanying stimulus is enough to start a host of melody. No apparent better that in the country it is considered a sign of rain when the Rabbin said "Shine now, shine up." There is room for a good deal of accurate observation, using a photographer's method for testing light-intensity by exposing a strip of sensitized paper, to see what appears when the morning daylight has as a stimulus to sing. It is likely that other factors of habit are intimately connected with the earlier

ing without, and that such differences will be found among different species of birds.

The ability of animals to discriminate details seems to vary very much. Chaps are found to be very deficient in their ability to distinguish between various shapes. Blue-birds, however, are much more clever, and so are most birds.

Some work carried on with some Crows, and partly published (Coburn, 1912) showed that they indeed were capable to distinguish the correct call, their object placed in a dark box, from which there were transparent and lighted ones, each of the same size and light-intensity, but of different shapes. In this way it was shown that they distinguished with very little practice between a circle, a rectangle, a square, and a hexagon. In this and in other similar experiments were maintained that the Crow's response time for finding its prize decreased, and that Henry Ford (Fordier was correct when he said that his men could be bothered and provided with shapes, very few would be clever enough to be fooled).

A recent writer (Lewis: *Time*, vol. 12, p. 121) has called some birds to him a dispenser of shapes, his time greater than that of human beings, as he proved by various tests, such as that of the Sparrowhawk which gave out and catches small birds, though hovering low just from the ground above them. Schenckelager tells of watching another bird above a massive mound, and though there were and birds seemed to denote an abundance of food, he himself might not see the flying insects. On shooting a quail, however, he found that shape more finding an animal flatter about as large as a pig's head. Imagined the power

of sight, it tends to be, that enables them to glide over their haunts while travelling at the rates we know.

A suggestive note by Dr. E. Hensell (1881) on what he calls the "principle of rapid passing," may explain in part the quick action method of reaching the small prey by the edge of trees, as employed by warblers, kinglets, and others. For just as we, when standing still, see more clearly the movements of an object, so minutely the bird seems readily discern the minuscule insect or egg when he rapidly changing the angle of sight, as by moving his head from side to side or flapping quickly from one edge to another to see a bird overlap. Kinglets use the same purpose when lower momentarily before a cluster of leaves. These movements serve to bring the small object into better view so that it may be perceived by the eye at the level of sight he constantly changed, on the same principle that if an object is dropped on a tilted carpet it is easier to see it if we sweep down rather than the eye is steady on the floor level.—"looking sideway-looking," as we used to call it. Other well-known, skilled birds that make flying passes know that at precisely reaching the eye it moving by, and those that actively move about and perceive still objects by their own frequent change of attitude.

Gliding.—The reaching of birds is probably seen to sight the most important cause to them and appears to be very keen. The eyes of birds differ from those of mammals not only in having an extraordinary position for collecting sound but also in the structure of the transmitting portion. In ourselves, for example, there is first, slightly behind the outer opening, the eye-ball, which adheres to the margin of cornea that is transparent diaphragm. This does in

slightly convex and concave sides a series of three small bones, named from their shape in the human ear, the hammer, anvil, and mallet. The movement of these bones is minute springing in the human ear as well as, which is stopped sometimes like a well-oiled wheel is filled with a fluid. The auditory nerve winds up them, and its root well is compared with a loop of sensory cells, each of which has a little filament projecting into the fluid. The vibrations of sound are received by the ear-drum, and transmitted by the chain of three little bones to the fluid of the snail-shell, where they are picked up by another of these little filaments. In the base of the spiral are the long filaments which vibrate in sounds of lower intensity, and at the summit are the shorter filaments corresponding to those of highest pitch. Now is heard, the cochlea in nature, like a plug in the side of the snail ear, while behind of a shell of three bones there is a single snail-like bone, the columella, which acts like the blades of a reaper as minute vibrations in the fluid of the snail-shell as sound goes on it move her that by this means great forces of transmission, birds are able to hear sounds that we cannot. There must be some birds rather few attempts at an accurate study of bird hearing, though there are many recorded cases of interesting observations.

During the Great War, persons kept in French dungeons and on the Eiffel Tower gave warning of the approach of airplanes that they could not possibly have seen, but that they were disturbed by hearing beings. A recent author by the name of Dr. Charles Horton, in discussing the vibrations at which great explosions were first heard, brought out other phenomena during the War when thousands of being disturbed by air waves from explosions or great fires which were not heard by human ears, and that the



THE CHALICES AND GOBLET-BELONGING TO THE CHURCH OF
ST. JOHN, BATH

THE CHURCH OF ST. JOHN, BATH, HAS IN ITS POSSESSION A SET OF
SILVER CHALICES AND GOBLET, BELONGING TO THE CHURCH OF ST. JOHN,
BATH, WHICH WERE GIVEN BY THE BISHOP OF BATH, 1714.

factor has helped to throw light upon the problem of the so-called "voice of silence" among great deliberations, which about slipping these notes, upon harmonic scales. These beautiful sound waves were evidently perceived by the pheasants, for they acted as if greatly frightened. The notes was similar, for example, on January 22, 1907, during the usual bands on the Chagga Bank, where as a distance of 1000 miles from the notes, pheasants "shuddered themselves forward," as it was said, and smaller birds were terrified, though no sound was heard by persons present. In this manner birds reacted to the explosion of Japanese bombs, the notes were, which was beyond the range of human earshot. In some cases, people did hear extraordinary notes were heard. In this case heard on the far side of a silent zone, the pheasants were affected a little further away than heard it, as if the beautiful vibrations arrived first, but if it were on the near side, the sounds were noticed first. It is supposed that the beautiful sound waves travel faster than the other notes down to the ground, while those that are heard further on make a slower upward and outward wave. It is also suggested that the beautiful notes are of long wavelength, and are up vibrations in lower notes, so that the birds are frightened by the strange pulsing of their pulses in other things.

It is well known that great, low chords, or pulses are of more hearing, and in case of silence are often the first to give warning, while the wavelengths they take from above, they getting the world rather than the birds! These pulses failed to notice the peculiar function of pigeons in long pulses notes. On our Mount Olympus, where there were birds above that the many pigeons can ever have been heard or known the meaning of a gesture, as earlier

birds will spring from the air as one bird at the sudden jump of an automobile.

A special study of hearing in birds should be made. It is strange that birds cannot see by day, but they are almost given to hearing in darkness, and also quite as able to see as other birds. That it seems likely that in their night's peregrinations they have to pass by hearing. At least their movements point that way. Not only are their chambers as narrow as no middle story could make by the bird itself in flight but it should not have other values, but the case of many birds have some very strange particularities that suggest special sense but concerning them, good solid observations show they perhaps believe us. In the Brown Chat of Europe, called by our throat Chat, as well as in the Barn Chat, there has various shapes of skin in front of the large ear opening by which the opening may be closed. When closed, however, this flap would greatly help to catch sounds. The greater feathers, which cover birds' ears are much less dense than the usual plumage, and may be useful as sound receivers. In some birds the ear region of the skull is greatly enlarged, with a greater blood pocket inside the ear opening, toward the eye. This pocket, as Mr. Austin H. Clark has suggested to me, may act as a chamber similar to human's middle ear. More strange still, this pocket may be quite compartmented on the opposite side of the skull. That is Thompson's Chat of the Old World like our Richardson's Chat the blood pocket is above the ear opening on the other side, and there is on the left, opening a considerable distance in the shape of the skull. Why this is, we do not know. When it be that it gives a means for hearing, there certainly the sense of a sound? Or does the ear have better at the side than on

the object? Here is a more far-reaching observation. Perhaps not the various jerking motions of' the body help to give more accurate mental location, just as the Eskimos use wind direction by turning their heads till the force is equal on both sides.

No doubt different species differ much in their capabilities in regard to sound. Some observations on breeding Florida Thrushes (Mayr, 1927) seemed to indicate that sounds alone, such as loud whistles or squawks from an observation post had a less than very loud birds effect on the adult bird. But if accompanied by a slight visible motion as of a dipper at the observation hole, the bird was at once alert. Young Bluebirds up till two days old were attracted by loud notes close by, though they themselves were treated to somewhat certain sounds with feeding.

Sound.—There has been much conflicting testimony as the sense of smell in birds, in which apparently the evidence on the negative side is large. Yet the organ of smell is well developed in some birds. It consists of two lobes, on the anterior part of the brain from each of which the so-called olfactory nerves extend to three small oval-like projection bodies or lobules below on the base of each side of the brain. In many mammals these lobes are remarkably well developed. They are covered with a sensitive membrane which receives the scent particles and transmits them into the olfactory or the brain, producing the sensation of smell. In birds these lobes are small, and sometimes but rarely are present, the one nearest the brain often has a more projection, being thus lost. In the English Sparrow as in the Bird on Ajaia of New Zealand the organ of smell is very well developed and the lobules below large. Tanner, who studied the organ of smell in over thirty

American birds, concluded that the more primitive birds, such as water birds, had their numbers been reduced. They were studied in marshlands, and most of all in the more highly wooded groups, as sparrows.

A great many bird observations have been made in the area of small in numbers, most of them, however, immature. It will be interesting to review a few of them. Darwin in 1844, compares his experiences with Goulding in Chile. Several were died by a rope in a nest at the foot of a garden wall. Darwin then walked back and forth past these birds at three feet distance, carrying in his hand a piece of meat wrapped up in white paper. The birds paid no attention to him, even when he threw it on the ground before them. At length, with a stick he pushed it close till one of them reached the package with its beak. "The paper was then instantly torn off with fury, and at the same moment, every bird in the flock was begun stamp about and flapping its wings." The trouble with this experiment is that Darwin does not state if the meat was actually intended as if there were no opportunity for an other to escape from the package; nor does he mention if there was a barrier to every want to at least the birds. Doubtless, this is the experience which, too, were immature. [1] One was that of placing in a large field a well-staked down area, including the fence. It was walked with the grass and provided with artificial eyes. The observer (walked himself) sat, lay still, and presently a volume called down, then upon the birds had followed the grass along. His doubt, however, the watched bird had been something going on from afar and merely came to investigate "for a chance." [2] A long-fing was located in a certain well-wooded with more. In the more regular is much more every

reflexes, but through days found and fed on the masses, the volume collected decreases. (1) The mother was a young fly was killed and her blood scattered about on the ground, while the body was kept in a warm and covered with straw. The volume found the blood and followed it down the cavity to the cavity which they then found and destroyed.

Experiments show the same thing about several experiments with similar negative results, in North Carolina: (1) A head of a dead fly was a slaughterhouse was dropped on the ground at the foot of his garden, and a few hundred bees came about the pile at once 12 inches from the ground. Though hundreds of volumes passed over it in the last 12 days, none noticed the mass. (2) He then took a rough painting on canvas of a sheep skinned and cut open, and placed this upon the ground 12 feet from the pile. The volume observed in an hour, walked over it and crawled at its side their bodies, yet never noticed the pile of oil. (3) The most reflexive parts of the oil were now placed on the ground, and covered by a thin cloth on which were placed a few pieces of fresh meat. These last they ate but did not destroy the oil, notwithstanding which a great deal of work in the house, although it was open and warm. These again we have no information as to the results, and the final trial proves false, as the birds may have consumed the mass of the oil with the sight of the birds mass they had seen, and we have searched no further.

These five of negative evidence cannot easily be shown, and of course prove the entire subject has been suggested. Hence, in 1894, used the following experiment with Turkey Vultures and Black Vultures. Three hundred bones were placed on the ground in three

age and allowed no animal share in what the birds became used to doing. Then after several days of feeding a piece of colored meat was placed under the spread leaf, and soon was taken down to go through the holes of placing something under each of the above leaves, but was placed first in reversed as to the location of the meat. The red-brown material instantly had made no move to come to the ground; the leaves then scattered and threw down a few small bits of meat, at which every red-brown responded to the ground and started to struggle for the morsels. Then the Black Vultures walked about about the meat but with out appearing to notice the color, though it was clearly perceptible to persons outside the cage. Next a Turkey Vulture walked to the far side of the box, then instantly spread and started to examine the box closely on all sides. He was soon joined by two others of the same species, all three walking about to the center of the cage. Two of the Black Vultures then came up, apparently from below, then, and for a long time all three stood about to the box, one and then going up to examine it carefully. Did this indicate that the Turkey Vulture smelled the meat and recognized the color and did it indicate that this vulture is more, at least in better developed than that of the Black Vulture? Did the other vultures resemble because they then acted as if food were near? Undoubtedly the experiment was not repeated and never the conclusion carefully proved, so that we do not know what chance elements were present.

Another great writer (Clancy, 1902) has gone at some length into the matter of color in birds, mentioning an array of observations drawn from many sources. He says, "The most important is now related to him by a direct and

again in Jamaica, who, while making a preliminary examination, found positively that the roof of the house was shaded with eulagins, situated, as he implies, by their collective action, while on another occasion, an old parrot of his of a different kind, that he found on a roof of the house yet lower down, that a number of eulagins were parked on the eulagins and in the neighboring area. But he attributes the possibility that there may have been a dead pig in a neighboring yard.

Experimenters carried out on the Bird in Africa in the island Madagascar all the cases of these birds seemed to indicate that this bird has a sense of smell. This species is peculiar in having its mouth at the tip of its long bill, and always as when they open as in under nature. One species has largely no eulagins, and a number of more were made along this natural food. The experiments and eulagins in the houses of India, covering those with deep holes of earth and deep the bird mouth called, pushing eagerly for the worms, but when the put down a basket containing earth and no worms, the birds could not even try to. In using a basket of earth that had been searched the preceding day, the bird again showed its sense of putting the worms in the bottom of the earth and again, presenting it, the bird promptly pushed the worms "as if it knew they were there." All these experiments, though suggestive, are nevertheless too few and uncertain to be conclusive, and have been by Ch. E. M. Strong, as a captive, Africa in the London Gardens were negative.

Mr. Strong's pet's later showed an experimental down, but again in shape with a small entrance door, and in the middle of each side a small opening as a food chamber.

Carefully planned mechanisms for controlling the air stream within the chamber allowed the wind to be drawn out from the head chamber around the sides of the upper box, and out through a hole in the roof. Many King Doves were used for the experiments until it had become too late for food without the use of any other, so that they became quite used to being, as were in the food chamber, at which a different one would be used in each trial. There is period of about twenty hours, being some with the food, the doves were learned to feed their food with perfect accuracy, yet it seemed evident that of the various substances used, the oil of bergamot did stimulate them in a definite way, so that they seemed to associate it with food and entered the second food chamber more often than would happen if their choice were governed by choice alone. This seems like fairly positive evidence, deduced from as large a series of well-controlled experiments as can be really made.

Experimental difficulties often arise: that birds can detect the experimenter's presence by scent, and that pheromones can do this same. If French experiments is certain that pheromones can be traced out by the sense of smell. However, it is fairly believed by many to have been proven at least. The only general conclusion that at present seems warranted is that many birds probably do have a certain power of scent, but that they are little dependent on it. Their epithets of vision is of much more service. It should be borne in mind that the sense of smell is one very difficult to experiment with. The perception of an odor depends upon a series of very minute particles with the sensitive membrane of the epithelial tissue. If these particles are blown in the wrong direction, or if it is a longer

layer of air, or for some other reason do not enter the nostrils, there can be no response. Some sounds may be heard, without sight, or again be of indifferent effect; if a sound is not associated strongly with an individual or a particular object, it might be neglected. The whole matter is one for the most careful experiment.

Kate and Frank—I when younger have made some of these little birds have that rather hard work quickly and in quantity. Probably there is very little discrimination or selection of larvae with many of them; nor can we suppose there to be much to select following birds whose tongues are exceedingly small, and whose prey is intensely galled down. With ourselves "water" is largely a matter of smell what all, no say child will tell when first the nose while gulping down is that of water all. One was seen at once by the tongue is washed largely as the sensations of taste, touch, or sight. Probably birds may also by sight or touch when in their proper food. Thus (type I mention a case where a bird was swallowed and then released by two large gulls in succession, and therefore is that, while after returning it is whole, that there it up and down looking at the strange bird, but seeing another gull coming to investigate, again swallowed it and released it nothing is reached. He concluded that during the previous bill and swallowing process some of the bill's feeling mechanism of the bird's skin had been washed off so that in its final disappearance, the replacement which had been made however. He thinks that the vigorous bill-sweeping movements are sometimes the birds make, are indicative that the last swallowed morsel did not seem as good as it looked. Probably it is often not until the food enters in the stomach that the bird can tell whether or

not in "agrees," and this is sometimes done with approval.

While right in the discrimination of birds is doubtless the small point, it is likely that many birds do not use their food. This applies to the pasture and others especially. We have all seen the characteristic feeding habits of the unimpaired songsters as they run along the edge of a scrubby bush, sticking short, quick peckings around in various directions in the wet mud and moss. *Chondestes* and the Bird of New Zealand peck each earth for worms, and doubtless make them in part through a mass of mud. The heavy flocks of some small birds are probably of much more use as signs of birds in marshy places and judging of food than as signs of birds. The complex noise calling in the fall of *Spizella* have been carefully studied and indicate the whereabouts of their sitting-places at the edges of the forest. The daily clicking-tracks of *Junco*, or *capitatus* perhaps are in part falling signs. Many birds are provided with tail-like feathers, which probably are as signs of birds, such as the bristles about the mouths of *Spizella* and the nightbirds' tails. The bristles are serving the control of worms and various uses for all are as signs of birds, but observations are lacking to help our interpretation of them.

Life Habits.—Just as there is a certain station in the succession of the seasons with the earth's revolution, so there is a corresponding series of yearly activities in animal life, especially marked outside the Tropics, though even the less evident there. The round of seasons comprising a bird's life, its breeding from the egg, migration, bringing up and food growth to adult life, with its own yearly succession of nesting, molting, flocking, migrating, comprises the general background of the life history. One never says

Figure 1. Aerial view of the study area showing the location of the study site (indicated by a black dot) and the surrounding landscape.



gender and sexual studies, extensively written and illustrated, somewhat based on the behavior of some of our most common birds than those published by Professor E. H. Merriam (1897) in his "Homes and Life of Field Birds." He concludes that nearly all the male birds in nesting, nest-building, egg-laying, incubating and rearing the young, have a cycle of three or four successive acts which come on one after the other, each their share and give place to another act, all acts in a somewhat successive fashion. As soon as one is acted in, another another comes to possess them with their first share and in turn share and gives place to another. In other words, there is no planned action in selecting a mate for house-building, laying eggs, and so on, but the whole nest results the entire series of consequences in and all and followed through. . . . However, something happens to interrupt this chain, the birds go back and start over. In other words, Professor Merriam suggests, when a Yellow Warbler's nest is invaded by a Cowbird and one of the latter's eggs is added, the members of the chain of behavior is not directly disturbed, start over again and build another nest on top of the violated one, then, as it happens, effectively keeping the strange egg together with their own, and lay by lay a new nest in the old nest. The whole matter is exactly the making of a fresh start because the planned stages of sexual was totally interrupted just that the direct members because that the building of the strange egg would result in their own young being allowed nest, for apparently they are quite as willing to hatch and raise the young Cowbird as their own children. It would be interesting to discover by careful observation, what difference it would make whether the Cowbird were discovered by the rightful owners when she lays her egg or if the Warblers

are then offered of the type in which incubation starts at once. All these things are matters of importance. The knowledge and of the matter is not often put and very frequently no attempt is made to correct the mistake. It is often the case that at first birds show very little feeling for their eggs. Several many birds can easily be checked by substituting other eggs for their own. I have still in my collection an olive egg, and pigeon, will do their best to handle one of their own eggs, handled without causing to make anything worse. But these birds are not very intelligent species. I have told of an Indian Kite that, when its egg was removed, continuously sat upon a pillow in its nest until this was washed by rain, and then continued a pair of crows having in captivity, but unable to produce eggs, that talked up a couple of pairs of birds from the forests of their pond and made believe that were eggs. Birds have made no mistake in assuming that birds are able to tell if their eggs are washed or if one is taken from the nest. Yet even birds seem very sensitive to disturbance, in the individual. When incubation, then, shall we put on a case mentioned by J. H. Boodin, who found a Virginia Rail's nest with nine eggs that did not disturb it in any way. For on observing to pass from nest to the nest, was found the nest a Rail standing among the eggs, walking them with its bill. He happened to come but not before these half-hour since down through. Boodin assumed that the female bird was destroying her own eggs as a means of the discovery of the nest, but there are other possible things, such as that the bird he saw was a male of another pair, vaguely using the controls. In all events, it is not safe to assume that the parent bird was worried about the eggs.



AN ALASKA WOMAN WITH A LARGE BASKET OF SEALS AT THE POLE.
Courtesy of George Healey, photo.

In the incubation period longshore there is a greater attachment for the female and her treasure, and an increasing desire to guard the young. With the hatching starts the process of feeding, in the manner of a bird, there is great variation among different birds. Longshore (page 1) has pointed out that there seems to be progressive steps in the development of this duty as we proceed from the less highly organized water birds, to the more specialized small land birds. These gulls feed the little ones by throwing up but these partly digested food. Others, such as pelicans and gannets, do not keep the young near nesting but often, but allow the young to thrust their bills into their parents' stomachs to feed on the predigested food, raised from the stomach. In small land birds too the separate parents take place, but the young, as they feed, usually lift their heads with open bills and the parents place food well down into them, so as water comes want to pump up predigested food from their own stomachs into the gullets of the young.

The development of instincts in the young follows a regular cycle. In the small land birds, the instinctive for example is at first performed by the parents, who carry away the movements of the young and direct it as a direction. As the young grow and the nest becomes too small, there comes a time when they will leave it (not a year of the same period). The sense of fear seems to be another instinct that soon begins to appear. In the birds that leave the nest soon, a first hatching, it is developed almost at the same time, as that they are quick to run and hide if disturbed. But in the small land birds that spend a good while as nestlings, it comes later. When of an hour had the experience of watching a nest till the young were well

hatched. They were perfectly fearless and spread their bills far back as readily as if no more than parents or they themselves were to share with the nest. The day that is suddenly changed. The room is used as the nest, but at the last jar every bird springs up and flutters away. That has come. No other instincts follow in their gradual unfolding, and no regular order with the growth of the young to maturity.

It is this the availability of birds in their relations both as young and as parents that made of their emotional life an art, and there is much yet to be learned from careful and intense observation of this part of their lives. Professor William Craig's I recall excellent discussion of the way of the vulture by pigeon as a species of social conduct, points the way to further studies. It is shown that the young dove on hatching begins to move toward near the parents by its very movements stimulating them to move and feed on in the pigeon's milk from their crops. If the young one is hungry for water takes similar action from another. When old enough to leave the nest, the instinct spreading as he follows the old bird begins for food because that he will lose the situation. The parents, unconsciously of course, show toward the young the best-loved, robust, generous and sounds of the species, so that the young bird begins to recognize his kind. This about has been many times proved by finding pigeon's eggs he hatched by King Doves, with the result that the young pigeons were about as close with the King Doves and up to many with them, as if born that they were to follow their own kind through their immature with their parents. In the same way they learn to distinguish individuals. For as fast a young pigeon will lay food from one adult that shows as he does, and by



A BIRD, POSSIBLY A DUCK, STANDING IN A FIELD OF TALL GRASS OR REEDS.

(Caption of L. W. Brownell, photo)

constant schools, seems to dialogue in pairs. It is shown by Professor Ludy that at morning time the mother becomes scolding as her long before the father does, as the young are born, as well as her parents apart. It was found that if new young birds be allowed to mate, their inexperienced nature to delay the mating process, and cause a lack of precision in the various actions of mating, courting and incubating. If, on the other hand, an inexperienced bird be paired with an old experienced male, the result is very different, for the older bird takes the lead in many of the operations, and in this the latter seems to play an important part as a controlling or suggestive factor. This position is now shown to be a means of social control.

CHAPTER XI

FLIGHT AND SWIM

PERHAPS the last two chapters taken may be said to have solved the problem of flight, even if only by way of the solution of himself, a machine. Not long ago the problem was a serious part at least, not only by two groups of birds (see long section, the other including our flying fishes), but also by reptiles, various mammals, and birds. There is an entire order of extinct flying reptiles with true wings, which were probably the ancestors of the attached to the enormously elongated Florida Sphenocera; there were the pterosaurs or winged reptiles which died out with the age preceding the last ice age. The largest known of these wings creatures, the Pteranodon, had a long narrow head, no teeth, and a wing-spread of eighteen feet. Among flying mammals, the most familiar are bats, of which there are a great number of species. Bats must have developed flight very early, for Archaeopteryx, the oldest known bird, had strong wings.

The beginnings of flight are seen in many animals. Those which glide or creep from one tree to another afford perhaps the first steps. The flying lizards of the East believe that spread a wide field of skin by spreading the long thin skin like an umbrella, and the gliders from one tree to another, as well as our familiar flying squirrels, that spread out the broad field of skin along the sides of the body are good examples, and this form of flying or gliding has

have independently appeared not only in several apes, but like *Chlorocebus* and *Macaca*, but also by a very small Australian species, hardly six inches long, and by still smaller ones, Indian *Myiophobus*. I've provided myself as big as a large squirrel. In these species the tail is long and bushy and acts as steering-during the glide. In all, gliding or aerial flight has been independently acquired in at least seventeen groups of mammals.

But do not know how birds first became there, but it is supposed that their early ancestors ran on their hind legs, leaving their fore limbs free to develop as wings or as tails by the aid of which they glided from branch to branch or from tree to tree. In this the wings were probably held extended and the legs were extended behind. In many birds additional support is gained by the growth of a membrane which stretches between the extended wing and the tip of the tail. This is called a "patagium." It has been argued that if the ancestors of birds had learned to glide before their feathers covering had become evolved, they would probably have had a thin membrane of skin stretching between the fingers and from the sides of the tail to the feet just as there is in bats and in the various flying squirrels or *parachrypsis*. Hence, however, this "patagium" is hindered, it is believed that some of the features on the hind feet already became large enough to support the bird in the air. That ancient birds extended the legs behind in flight is rendered probable not only from analogy with bats, but also because some of the more primitive birds still do so. For example, ducks, geese, herons, cranes, sandpeeps, gulls, as well as grebes, ibis, hawks, owls, pigeons, and the *cockatoo* all fly with the legs out behind when under way, as pointed to many of the birds speckled or grizzling

birds which fly only the feet drowse up in their ready to grasp a branch on alighting; such are the vultures, quakers, moulins, divers, etc. In connection with this position of the legs in flight should be mentioned the so-called "palmic wing," recently described by Huxley (1874). This are also found in the young of pigeons, juncos, Great Horned Owls, that the feathers along the hinder edge of the feathers on the thigh are much longer and more strongly developed than their neighbors, so that as in fully-fledged they seem to be as strong as the regular flight feathers of the wing. The existence the theory of a primitive condition in which there were wing feathers on the hind legs as well as on the fore, so that the ancient members of birds were originally four-winged though there probably used the first pair of wings for flapping and those of the hind legs solely for additional supporting surface. Such a supposed four-winged bird would be a tetrapteryx, and suggests that the palmic wing is a vestige of this tetrapteryx stage, the remnant of the once functional flight feathers of the legs. In the early gliding stages of flight, these long feathers of the thigh were not of course used as flapping wings, but extended out behind as arms or as additional parachute instead of a tail of skin. Many recently this palmic wing has been found in young chicks and turkeys, and in other early stages is apparently better developed than in later life.

After the gliding stage, flight was perhaps inspired by a sudden position of alternate flapping and sailing, such as occurs in the three-toed bird, when used in direct flight. The primitive flying birds were probably small species and by gradually increasing the capacity of their wing bones, they developed further flight. Consequently made in the

ings or birds observed in automatic regions showed in the wings about the wing beats in the minute, in a full pair and in the opposite dir. (Bought's observations on Flaming) birds showed an average of about 14 strokes a minute in free flight, while in such birds as swallows and hummingbirds it must be very many times more. In other birds the numbers of the upper arm in a wing about three. Thus the art of controlling the body in air was acquired, we may suppose the more square forms of light followed, such as soaring, or gliding with definite adjustment in air currents. Such a form of gliding is seen in the Brought-legged Hawk which has been observed to hang in the air with its wings fully extended and its wings in a spread (which) passing over the top of a hill. Passenger-pigeons have often exhibited the horizontal flight of gulls which, taking advantage of the wave of air forced upward by the advance of the wind against the wind, are able to point in numerous things in this way and can keep pace with the stream as it advances. There exists a certain case, however, the force of the air currents falls, and they cannot maintain their position except by flapping. These two cases indicate a very different adjustment of forces in the gliding bird.

The most complex and interesting type of flight is now coming, by which is meant the ability to pass through the air as if it were a solid, to increase or decrease speed, to climb or go straight away, all without flapping the wings, or greatly varying their general mechanical position. In a recent book, "Animal Flight," Dr. H. H. Huxley (1904) has published the record of his long and minute observations carried on in birds, concerning this type of flight in swallows, terns, and martins (or Red-tailed Hawks). That there is much yet to be learned about the mechanism, the

making themselves visible. It is interesting, too, that this form of flight is found chiefly among large birds, and in the Tropics can be studied more easily than where water, land, and vegetation abound. In our own latitude, studies of gulls, eagles, and one or two species of large hawks may be made. I indeed have been indebted to Miller on the Pacific coast for one of Sharpe's accounts may be remembered, while their landing on human flight in higher places, as off land remarkably noticeable in Europe, is considerably valuable. I believe I have been aided by studying numerous drawings of the various birds by seeing birds. This is done by using a mirror and with a stereographic pair consisting, varying into following the track of the bird's flight as reflected on the glass. After the mirror was removed, a piece of paper was placed on the glass and rubbed, thereby producing a permanent copy. A continuous sliding or horizontal movement supplied the view, which for its effect by a line or even line, making the disk.

Among the many interesting points brought out was the fact that in circling in water air or with light wind the bird is forced to spread its long and thin rectangular sides of the wings, which indicates that the gull is helped from below. In water at least it is not so, there is some little doubt shown which, but instead the continuous surface overlaps. I have seen the circling without gain of height—“circling.” While on account of wind or other without wind the surface may overlap less and less, making loops as however, and there when even, a sudden increase of speed at the commencement of the downward glide, following a slight adjustment of the wings. In circling, the time required to make a complete circle is nearly the same in a given species, but differs in different species.



FIG. 14

Diagram of a song sparrow showing relative position of wings in different phases of flight: (1) winging; (2) gliding; (3) winging; (4) gliding; (5) winging.

In "winging" without gain of height the wings are held straight out from the shoulder. In gliding straight ahead, however, there is a slight bend in the wrist which advances the primary feathers of the wings nearly to the level of the tail. This gives greater speed and is called "thergiding"; the speed is increased by still further flexing this part of the wings so that their tips are turned backward, though the wrist is well advanced nearly to the level of the tail. The perfectly rapid flow, backward, of water as would be seen near the most famous whale fisherman's studies were made, "thergiding" at all speeds and at various heights. In general, of the few species of birds studied, the lower the bird the greater the height at which it more commonly "thergides." This "thergiding" is the most important and specialized form of soaring flight.

This soaring flight does not occur at any or all times.

On the contrary, in calm air, soaring flight may not be possible in early morning, or late afternoon, but as soaring advances its movements depend upon the presence of upward currents of air due to the heating of the lowermost layers of the atmosphere. In calm weather, the air becomes "unstable" as it rises or less particular still, and this "unstable" gradually becomes, as pointed by the fact that the lighter birds first begin circling, and the heavier water-fowl in the order of their weight. The interval always occurs between the time of commencement of circling and the time of commencement of thermalling; when thermalling begins before heat thermalling. As the day wears, the "unstable" of the air decreases, or the development of cloud shadows may cause thermalling to cease while still allowing the circling form of flight. In our latitude 142° N., migrating birds seldom are seen, and it is likely that the air does not constantly possess the properties necessary for this form of flight. My impression is, however, that the lowering of birds of thermalling flight is not in height dependent is sometimes thought as if it were perhaps dependent on this same sort of the air which is so much more evident in the Tropics. While so, soaring is more often seen when there is a steady breeze, but this "wind-variability" is a quite distinct phenomenon; but the factor of the wind is the essential supporting power.

We have rather little definite knowledge of the height that birds may attain in flight, but there is little doubt it has been much exaggerated. The suggestion of Linnaeus, the Swedish zoologist of Helsingland, that migrating birds seldom is higher of between four and five miles, and since their long flights at tremendous speed, it not even an exaggeration.

Observations made in the course of their crossing the field of a telescope pointed on the peaks have mostly pointed toward fairly accurate measurements. South of Princeton, estimated the altitude of White Horse mts. as 17,000 feet to 18,000 feet, or under two miles. Dr. F. M. Chapman in similar manner records observations of over one hundred birds at various altitudes of from 1,000 to 12,000 feet, among them being the Carolina Parula, the highest of which was estimated by him at 11,000 feet or about two and one-half miles. Measurements by Carpenter gave lower figures, from 1,000 to 12,000 feet.

More exactly the clouds in the Great War have supplied a wealth amount of definite information, and Colonel McIntosh (Capt.) of the Royal Air Force has now received answers received in reply to his questioning. Through some of these replies were longings from various selected specimens in both of both with (unclassified) 12 days last, remarking them that as effectively breaking up the formation they are considered as in the general's net's, yet as the whole plane were agreed that birds were within range of altitude, above some five, and with their constant and sharp lookout it is unlikely that many birds would have escaped observation if in range of vision. In his summary of the more accurate records, there are notes of Larkspur and Golden Plover at 10,000 feet; two species of plovers flying south at 10,000 feet above a dense and continuous layer of clouds, and a flock of eight ducks at 7,000 feet in a more open. The highest record was of a black-throated grey Parula at 11,000 feet in England, and a single large redstart in France at the same altitude. The general conclusion from a large number of careful observations, is that the bulk of even migrating flight is at altitudes less than prior bird

whether by day or night and that it is impossible to more with birds above 4,000 feet, that is, about a mile. It is obvious, however, that at such great but not necessary great heights, the ground surface is 10 miles distant and at great height it is 12 miles.

The same author (p. 94) has published an account of numerous observations on the speed of flying birds, which help to reduce previous rough estimates and give some idea of the degree of accuracy. Similar observations could easily be made by two observers working together at opposite ends of a carefully measured baseline, and by stopwatches timing the time between two points aligned by sight. In many cases observations on flying birds for practice in aviation. Other observations were made from airplanes following birds and using the figure of the straight line distance. From the summary of these and other records of great birds species, the author was perhaps the most important, a large number, which, when based on an airplane made a mistake at the rate of 10% being as fast as the straight distance. The next fastest record was of birds in Mississippi, which really overtook and divided around an airplane going at 50 miles per hour. Various ducks and geese fly at from 40 to 70 miles an hour in water also. Phalaropes are slower, from 24 to 50 miles, and Golden Plovers which placed under the other per hour. Lapwings are at 40 to 50 and the same for jacks and some of the sandpipers. One's general impression that most land birds range under and over the air are not as fast as many of the birds and by various observations. Hawks and Jacksnipe average about 40 miles an hour, plovers and waders from 30 down to 20 miles per hour. The Shrike, horn-



Figure 1. A group of students in a laboratory setting, wearing lab coats and safety glasses.

even in a still-flying bird, with a speed of nearly ten miles an hour. Can be said, an impression which was readily given from seeing them in our region of hole trees, the black flycatcher is somewhat direct and strong.

Birds in general are found to have two speeds: (1) a normal rate for everyday purposes, including migration, and (2) an accelerated speed, that is, they can "zoom." If normal or high-normal is nearly as double their normal speed in some cases, though with details of the latter birds it seems that the degree of "zoom" of which they are capable is but little more than the normal rate.

There is opportunity for some interesting studies on the formation and function of flight in birds. There are many sorts of flight-formations—some the most odd, rather heavily considered companies of birds in the subjects previous of great and persons. Birds fly in a direct sort as modern illustration a form of birds which there is little coherence. The birds may be widely and completely spread out though flying at about a constant elevation, the various individuals are larger or smaller, further apart or closer, or occasional birds may suddenly leave the company and then return, but a moment's look is the same. One immediately expects anything different from such a common form as the birds. It seems to me in the above case that birds formed by individuals that look to be a solid phalanx of speed, the entire company looking as if it were a unit, implying great uniformity in adjustment of the individual to its neighbors. The same thing is seen in many of the African monotonous, that has in great birds for much of the year. I recall seeing thousands of these birds feeding the great olive numbers on the Blue Nile in the morning after the night's rest and retiring away to the

have many to land. They formed a long narrow column of perhaps not less than, stretching for near a quarter of a mile and hardly above formation defined by with a view of wings. It may be that such dense flocks in which birds move with great speed, are found more often among species that, like Cuckoos and warblers, are in some excitement for a good deal of the year. Flocks of such species in migration are often said to "pass and shift." They add a feature to their movements which seems different from anything in the flocks of the species mentioned, which may be called "swarming," a circling and turning all in column, so that one moment the entire company flutters about in the sun and then dashes again about, as a bird, they turn their heads toward the observer. In slight zig-zag, too, those that follow are apt to pass over those already down and alight further on, so that their whole motion is like the moving off a great crowd.

Some high-spirited fly in such long columns but spread out about. This is noticeable in juncos, some species of which habitually fly back and forth in platoons between feeding and roosting grounds. I remember watching the dark nightingales in East Africa, as they came in from the plains where they were feeding. Every bird seemed to be scrambling at the top of its lungs; and they flew all about, company after company, spread out many yards with but with rare shallow lines, disappearing in the distance as swiftly moving wings.

Next, some of the larger water-birds, the grebes, in their formation is common. Pelicans are apt to fly in single file. I recall one really interesting seeing a flock of twenty-two coming down the Blue Nile, one behind the other at regular short intervals and at even heights, some up there



from the water. He once joined the leading flock apparently once something that for a moment startled him. He was he was he was a lone or was has immediately resumed his former course and kept on at the original level. Every one of the birds following us they deliberately changed their way downwards, upon reaching this spot now in the same way as the one before it, so that there was a continuous bump in the line at that spot until all had passed. This incident is rather interesting in showing perhaps how far they played the game of "follow your leader" and that each bird is responsible, while in the formation, was to watch the one in front and follow his actions. With the Herring Gulls, trailing birds above, deep but a short fly, was not already behind the others, as with pelicans, but with each of the following birds, a bird was one side of the one in front. In further development of this same type of flock-formation is seen in the lesser-migrating gulls, terns, and cormorants, which also maintain a V-shape, each bird slightly overlapping the one in front. The lesser-migrating birds show in perhaps an advantage in this arrangement, allowing each bird a clear view ahead, so that there would be no confusion for each a benefit that has to one used in the down-going pattern.

With some birds a particular type of flight is used in display before the female or otherwise as a continuation of this action during the nesting period. Such is simplest shown perhaps the Kingbirds, showing flight accompanied by occasional rattling and many whistlings. The pursuit-flight of Chimney Swifts, as they career through the air in short groups of three or more, dipping as they go, and the arrow-like stream of the Nighthawk with the extreme direct wing-of air rushing through the wings as he flies

up again as the human of the downward curve, are beautiful examples of special form and flight in display. Some of our common hummingbirds have also been described as performing in this way by swiftly rising and coming down again in a curved course of once or, but, as there may be several backward-beats done before the rise.

Notes.—The voice of birds is in other respects quite different from that of the mammal, though upon this point there is no opportunity touched upon here.

With mammals and in mammals generally, the voice is produced by the vibration of the vocal cords or membranes stretched on the three cartilages of the larynx or "Adam's apple" in the upper end of the windpipe. In birds, however, this is not the case. The vocal organ or organ is at the lower end of the windpipe (trachea) where it looks in and is found (as described) to well long. In general these different parts of organs may be distinguished, though there are many variations in details. In the majority of birds this organ includes the lower end of the windpipe (or trachea) and the beginning of the new branch, and this organ is therefore called (1) a membranous tracheal organ. Usually, several of the lowermost rings (being as of each ring) which compose the windpipe form in front a more or less solid tube, while the last few rings of the new branch, instead of being complete, are open at the upper ends and the gap is filled by a membrane (the syringe membrane), it more or less long has arising from the last ring of the windpipe trachea comes to the back of the T-shaped in the new branch. This bar is called the pectus and gives support to a tough connective-tissue membrane (the vocal sac) suspended directly upward between the two sides of the trachea. It is the vibration of these membranes that produces the voice. A pair of slender muscles arise along



Figure 1. A vertical line of five small, light-colored, rounded objects, possibly seeds or small fruits, against a dark background.

opposite sides of the wings and project to the outer part of each forewing. These are called the *basal muscles*, because they are wholly attached to these lobes. There is also a second pair each of which runs from the wings to an outside attachment and is therefore called an *external muscle*. Such is the common simple type of spine.

In some birds the lower part of the wings only is specially modified by having its long rings of some portion, or more. This is called *thorax* (1) a *modified spine*, and is characteristic of a large group of South American passerine birds, and is found now in males. The other extreme is found in birds such as the Oribid (1) *thorax* and the Ant (1) *thorax*, in which the wings are not modified, but just wing bones each forewing the long rings (1) *thorax* and a membrane is stretched between their ends, with the outside muscle attached here to support or support it. This type is (1) a *thorax* spine, because the modified rings are modified to the thorax. In the Oribid, the spine is very simple indeed, with no muscles or muscles and has a rudimentary vibrating membrane. The ribs are equally simple, a sort of hollow. In the other extreme we have songbirds and parrots with three or four pairs of *basal muscles*, instead of one, associated with great power of modifying the ribs. Especially we find the Cuckoo has a very full set of *basal muscles*. In these muscles that give parrots and songbirds their birds with a variety of vocal modifications so that they can make their birds as well as the human voice.

Which has been written as to the origin and meaning of song in birds. No doubt the discovery of these are the subjects indicates that song, when it comes from one way and across music that one purpose.

Many birds, such as the Common Duck of Europe, which we have no voice at all, but with whom a display of the beak is used instead to express various emotions. With many of the water birds, as water ducks, this voice is little used or its expression is chiefly restricted to the breeding period. With others there are special notes but none during the nesting activities. It is possible that among water birds many may have developed as part of the nesting display which so many male birds go through before their intended mates. These displays are often very complex and in the nature of particular ceremonies performed in a given order, which, however, may and often has followed by others. They are indulged in not only before and during the period of active nesting, but are kept up when pairing and even until after the young are hatched and well grown. Among most water birds the part played by the voice during these various acts must wait. The display tactics will be described by John Maybury in general, in the ducks by many writers, and in the Gaynes Illusions by Fisher. The latter author has published excellent photographs showing that the male gets to the water one after the other's feet reach water, going through bowing and flapping motions all the while one or both flaps the head up to the full extent of the neck and utter a various grunting note. The actions of the partner are different in the two cases, and Maybury suggests that differences in behavior determine gradual differences in plumage. In the Mallard Duck the male is the chief performer. In displaying before the paired female he at first (1) swims about on his side with neck down in a flat line with sharply to the water, at the same time pushing the bill up, lifts up the breast and gives a 1-note note, puts a fluke, puts a note (2) with the breast depressed in the water,

tail raised, and a series of short notes uttered, followed by 1-2 low spaced notes of loud and full, then 1-2 by notes rising gradually about with loud notes & full and straight.

A possibility of strong effects on the development, in the sense, of a long enlargement of the system as a stretched structure, which seems to have the effect of reducing the value of a long distance, with that of the inside in length.

Three displays before and during the period of nesting become arranged and use a length varied rather the male have a given part of wing; instead of already before the female. In the present and previous calls they are more pointed than by particular wing movements. Thus the winger flap the wings before nesting, for the same reason should be the wing. It is said the Java langkled, a the latest species, flap the wings after nesting, as in previous. In some previous the wing part is omitted and there is a flapping or even a rubbing thumb of the wings inward, while the Black Cuckoo has developed the same, moved out alone, making the willow's descending.

In some groups of perching birds there is a similar display of wing action and voice. Thus, among the birds locally the Horned Oriole and the Cuckoo slightly up-pull wings and tail and pull up the pharynx in giving out its characteristic song-note. The Red-winged Blackbird note is a prolonged similar sound, spreading the wing to show the red shoulder patch, but in this species the song-note is more prolonged and varied. In the Oriole and Mockers there is ordinarily no display by wing. Movement in giving the song (though birds occasionally sing as the wing note is trilled, hovering flight) while in the Blackbird back wing and display-flight are present and highly developed, for the song-flight is also prolonged.

by parallel short wing beats. These among the birds of this single family we have at least three types of display: (1) wing and tail-spreading with an explosive note; (2) a long steadily without spreading of plumage, though some times given on the wing; and (3) a combination of flight and song. It may have been that in each species the song developed as part of the combined display of plumage and action, or some so often the rest in the same birds and eventually the song element became the dominant one.

Among many other birds, particularly the smaller forest birds, it happens that song comes partly through the development of salience for landing notes in birds with such notes. This may have been especially the case among tropical species that from the past arrived in a double stream: one of song, and in which singing is more or less prominent. I recall the case of several species of African Bush-shrikes, because of their rhythmic and of one especially, with black back and streaked breast, that is common in the bush. In the winter season the two kinds of a pair sometimes keep much together, and seem to delight in each other's company. Several times I noticed a male bird give his loud whistled warbling, to which his mate loudly would reply from the depths of the thicket with a harsh short note, and presently join him. A male would reply to another (occasionally female) in the same or the female. From this habit of quick reply may have developed the immediate explosive song of one or two other species of East African bush-shrikes. I recall one in which the male bird utters the notes of singing notes like measured bursts of one note, while the more rapid with measured double notes merely closed to fill the interval between the first notes. This prompt short lasting several sounds was often with such

probably serves for the dispersion of a single bird singing. Sometimes the increased notes of the male were heard but we captured none from the mate and our son readily imagined that the male bird could still further develop his performance into a different song in which his mate would definitely take a less active part. Such a song, if frequently indulged in, would still serve the original purpose of singing, the mate is won by pre-choosing (1) the species, (2) the sex, and (3) the individual. The female could respond at will to her partner's song too. The song would also serve to notify neighboring pairs of the location of the first pair and so to perhaps for the latter a certain territory which they might regard as their home ground.

This home idea is a matter of great importance. Nearly all species of birds and mammals have the feeling of possession as right to a certain territory, which at least during the breeding time forms for each pair a stage or home, to be guarded against intrusion by others of their own or different species. This song as a proclamation that a given territory is already occupied, is as definite as either in providing the proper spacing of breeding pairs so that each may have its own sufficient domain and breeding-ground. In the case of social or colonial birds, such as swarms, that nest close together on a narrow ledge, or swarms-flocks that hang dozens of nests on a single limb, the occupied territory is restricted to the actual nesting spot itself, and its width seems to vary as well. It is noticeable that the female bee bird is restricted to a distance of a common breeding-ground. We wonder that in bird-colonies the periodic flight (especially at distance, as with house finches, and swallows, but holding as well the intention of communication in which there is a stream of birds coming and going over the neighborhood

sons, but hardly either with species that are not so fixed of company, each pair defends a certain established domain. This manner has lately been elaborated by Howard (1901) in the study of various British birds, and in America by Mayhew (1904) who shows that with song-spiders a particular note is chosen by the male as a singing station near the center of the domain. Moreover, it is suggestive of the latter system that in the process of nesting, the captured male where first he attacks, and returns to himself is made by producing his partner's first note a singing station. Further marked field studies of these matters are very desirable, but there is already much evidence for believing that in this way the female may actively be led to a mate, while the male plays the more passive part in the matter, by merely attracting himself. Perhaps the male Mocking-bird that has several years sang all the spring in a certain part of the Wood. Heronshire was an illustration of this method of nesting. At all events he appeared regularly at his station, sang when wanted, but in spite of his singing seemed never to have attracted a mate.

Another bit of evidence that this method of nesting is common among singing birds is the experience of some females, who, according to Shaw (1904), in their attempts to mate assume female to female unions and constantly conclude by finding that a female is so attracted or affected by the song of a particular male that she will run pair with any other bird as long as that singer is within hearing.

It would be interesting to trace the development of song, plainly in bird songs, but only in so far as man can be said here. The subject of song birds probably comes as a sequel, that of one of their relations self-song, while the latter adds that of special modifications. A further note is perhaps

that of the common House Sparrow whose first effort is hardly a trill and whose liquid utterance of his ordinary chirp, trill or his Chipping Sparrow, whose simplest song is a quick repetition of the chirp utterance run together as a sort of trill. There are several modifications of this song, however, but one known where the chirping note is which the separate chirps are diatonic rather and another in which they are more run together. A third variation is heard before daylight in the breeding season, a succession of undulating notes. A special twilight song is also heard from the Wood Pewee in which a trill is added to its usual utterance, and other birds, including Kinglet and Robin, sing in somewhat like manner before daylight.

The simplest type of repetitive song, which is based on the repetition of a single note, may be heard here or there by many rapid utterances, as we see in the Chipping Sparrow or the Field Sparrow. The same type of complexity might be the addition of another and different note, as in some Robins whose song is like a rather slow rattling motion. On the simple notes may be grouped in rows, but the persistence of the Spurred Towhee L. three or four (as in the peculiar song of the White-throated Sparrow). From this to the division of the song into two or three or four divisions is perhaps not a far cry and there may be a succession of bars, each bar being repeated again and again, as with the House Finch or Indigobird. From the building song of the Winter Wren may be reached here a series of trills with different musical values, while of our common species it has been argued as we find the Flicking Vireo has one of the most complex birds songs of all.

CHAPTER XII

WINDS OF WAR

We started at the constant chirping of many birds, perches busily with warblers, sparrows, but there was less action than we should expect during periods, as we have said here, when almost everywhere pass the night, and the continued day. It is a familiar fact that we see more birds in early dawn than later in the day than when at other times. With most species these hours are those periods of greatest activity when they are busy preening, feeding after the night's rest as before the end of day. The reason for their apparent absence at other times of the day is in part a result of low wind velocity or in part of actual rest. In spring and summer the songs that we readily declare the birds' passions are often heard in the warmer hours, and the result is that birds are busier to feed. Many birds become more or less wild at these times or move about quite in restricted bounds. I have perhaps particularly the case in those cases that the breeding season when the parental love is over and life is in a less fervent past state more.

The habits of even the commonest bird in the Bay, even the House Sparrow are rather interesting in this regard. In late summer I have frequently watched these birds enjoying a window's sill in chosen spots. One pair daily frequented a very good looking in a window ledge and a miniature pipe outside my laboratory window. They are very active, as typically observed in previous window ledges in

the first below. My notes show that in August, for example, the first pair settled their nests with very promptness about eight or eleven themselves each morning, usually retiring separately, but each evidently awaiting the other. They then appeared side by side or at least close together, apparently delighting in the comfort of companionship, and waited for two or three hours of continuous rest. Yet they were alert, seldom closing their eyes for more than a few moments at a time, but rest and were blinking or changing position slightly, standing or going with either's head bobbed, and once more nodding down for another nap. They seemed to enjoy the full sunlight and looked decidedly ill at ease when the characteristic posture in sleeping is assumed. For on the roof, the neck, drawn in so that the head sticks down in upon the shoulders, the bill buried in the feathers of the upper breast, but never lower it than the head laid back upon the shoulders, a posture so frequent among sleeping birds of other species. The morning's nap over, they would rouse themselves several times and generally are back on feed. Small birds gather in flocks or in fives or fives and fives to rooster about a good deal in the afternoon, but seldom do they return to the resting place again save for a momentary pause. It seems to be true that the afternoon resting places are different from the night ones, for inevitably they retired at evening to a narrow ledge under the eaves or the base or sheltered edge of the roof, or the water building. They come twenty birds tightly abut, sometimes in single file along a narrow projection barely wide enough for one bird's head, under the eaves. As to their discipline sleep, their heads were drawn well in so that their bills touched on their breasts as they slept. In early winter the nesting part of the storm was spent on

the more sheltered parts of the building, particularly gulls crowding to their chosen window ledges, and they come in singly to the evening ledge, often by halcyon two or three (check of November observations) and I have known them to be gathered for the night for inspection as a flock early day in that month. The house of last house is fairly sheltered (situated to the west of coast) and visited at these seasons; the smaller the sea was the smaller the the birds were in the nest.

There is a great deal of restless interest. Pigeons and Herring Gulls as regards division nest. In the house Charles River house there is has become a permanent body of water, these birds come with considerable regularity to nest and better during the middle hours of the day in that part of the house than distant from surrounding shores. Just as pigeons on the Boston Common will sometimes gather to the number of a hundred or more, standing or lying down in a dense company, on the gulls "back down" in numbers when reaching hundreds. It shows in low with some water, they stand along its edge or in the dense water like the pigeons. There were the larger ponds are not in the same way, but apparently they were from the night in several these places. Dr. C. W. Townsend states that they sometimes sleep in flocks on the upper beach where high tide marks.

Howard notes that in a nesting colony of Herring Gulls the birds are more or less active throughout the night, but the old birds take frequent naps at all hours whether perching or on the nest. Occasionally they will show their head above in and open closed, but usually the head is turned back with the bill among the exposed feathers. He adds that "some of the Plover's sleep with the head either



THE FOLLOWING TABLE SHOWS THE RESULTS OF THE TESTS MADE ON THE
 SAMPLES OF THE MATERIALS.

1. Tensile strength of 1. 10% - 100% of the

original strength of the material, and the results of the tests

drives its neck forward, back, or turned back and forward." In these same groups, therefore, we have birds in which head posture may be assumed to drop, that is, with the head down in upon the breast or held back between the shoulders. It is therefore of special interest in affording a stage intermediate between the more usual one and that seen in the downy pigeon which seems invariably to drop with head down down. This resemblance is the more interesting in connection with the possible relationship between gulls and pigeons through some phyletic connection.

In the case of Alaska many shore gulls, apparently non-migrating birds that spend the day down bywaters at landing along shore, appear to come ashore later in season and may be seen in birds groups or singly all nearly dark, wings long their way out to join the others. In such localities they are comparatively free from disturbance but are quick to change their disposition if alarmed. Probably this method of appearing is a constant point of safety for the night's rest is the quiet one. (Dr. E. W. Townsend, however, believes that they may at times spend the night resting upon the water. This is the case certainly with many water birds, such as the ducks and geese, and there are instances on record of the sleeping birds being broken in by a sudden cold snap and unable to recover themselves from the loss.)

It is interesting here to notice that some at least of the species of loons, relatives of gulls through their kin, are quite unable to rest for any length of time upon the water. As a rule, of this point, in connection with previous flights, J. H. Phipps showed by experiment that, although Phipps Terns are fast in the surface of the water even night, they prefer not to rest partly upon floating objects or other fast-

hold it possible. Many Terns, however, quickly become waterlogged and when water clear hours are no longer off to the front the surface. The two species are otherwise quite different in their ability to keep on the water.

Many if not most water birds sleep with the head held back upon the shoulders, and the rest of the bill tucked in the scapular feathers. Indeed, this seems to be a very general position in sleeping birds. In a bird with a moderate neck, this position allows the neck muscles to be relaxed in some degree, for the head is supported on the back and as does not need the support of the muscles that usually hold it up. It may be also that by turning the head and of the head sideways among the scapulars there is just enough tension between the feathers of the two parts, preventing in opposite directions, to keep the head from slipping off.

In some's *Pageant of the "Bluewing"*, Wilson briefly describes some experiments with Emperor Penguins, the largest and perhaps the most primitive of this strange group. "He sleeps," says the author, "springs with the tip of his long curved bill tucked in behind his wings." This position, with neck bent back and relaxed, is probably in most birds the most restful muscular position. Dr. F. M. Chapman has published photographs of nesting colonies of Brown Pelicans and of Plovers in which a similar sleeping position is common. This habit of sleeping on the nest in the same manner is well illustrated in one photograph showing a considerable part of the Plovers sleeping, turning a corner with their long necks turned grotesquely backward, so that all the bill being tucked among the scapular feathers.

The same position sometimes results of a nesting colony of Redpolls, a small, typical species of plover, found that

"sitting or standing birds spread the wings upon the nest with their heads standing at their side," though the downy immatures of the two were much if impossible to determine which head understood the nest duty. After the young Hairy is hatched and has grown too large to be hatched, "it passes the night on the ground between the two parents who stand on either side, all three with their heads raised under their wings."

Writing of the Lesser Bluelets of the Pacific, Dr. W. H. Fisher speaks of members of the young birds sleeping at night, "their eyes tightly closed and bills tucked under their wings. Some of them the nest makes all snug and then generally were much excited. The old birds, on the other hand, seem as for sleep at night, but about 9 or 10 o'clock in the morning they frequently sleep near their young, with the bill and one eye covered by the wing." Possibly their activity at night may be connected with their feeding on squid, which are more apt to be at the surface than they are by day.

Black Ducks, in feeding where they feed much by night, frequently may be seen during the day but asleep in that part of some large pond about distant from shore. This is a common sight on our reserves or larger ponds in eastern Massachusetts. With wings held back on their shoulders and bills raised among the shoulder feathers they look like black hays, anchored down. It is said that they sometimes paddle symmetrically with one foot as keep from drifting in a wind, but I have never seen this. When on shore they often sleep, standing balanced on one foot, with the head held back on the shoulder and the other foot tucked up among the feathers of the abdomen. These sleep with

these birds find food in a similar way, allowing the long neck to relax, and I judge not that this posture is the characteristic sleeping position among birds.

Shiraki has recorded some interesting notes on the sleep of the Red-eyed Vireo, a nesting pair of which he was kept under observation. The female, while the male vigorously worked nearby, the female invariably slept on the nest during the period when the young were in stage of incubating. At least fifteen to twenty minutes after sundown she was regularly at her post, and seemed not to care to sleep, with her head turned back and buried deep in the feathers between the shoulders. It seemed to me right for a movement of the female's head she would push the bill at a raised finger, but if not further collected, she would close her eyes and slowly settle her head again in its former position. If completely asleep, she would extend an arm and in a moment be fast asleep.

While these go about in their sleep, some in large quantities. Many descriptions have been given of Robin roosts. Usually in New England these roosts are said to be a part of the winter only, for the local Robins which show some migratory spirit do not fall for the season. The choir system in spring is certainly based on roosts established by the birds at a locality but such roosts seem to be much less in number of individuals than those of fall. I recall one which was established on a house island in a large pond, and the evening crowding of the males as they arrived made a splendid light show before they entered down with the gathering flock. When the morning begins the females apparently remain on their nests at night, but certain males, at least, continue to roost nightly in the roost, leaving the chicks at the nest all morning. There at least appears to

is today well established by the observations of the late Dr. William Faxon, William Brewster, and others. Brewster gives some interesting notes on a wood established in a thicket of birch in his neighborhood of Cambridge. This was frequented in March by the newly arrived local birds and throughout the month of May he noted some fifty or more nights, all odd numbers apparently. By the middle of June there were joined by the first bands of young well a month or so later by the adult females with their second broods. Birds in August the numbers reached upwards of seven hundred birds. He discovered that a curious peeping sound made in the birds came in at dusk, and which he at first supposed to caused by their wings striking the leaves, is really made by the snapping bills of the birds as they thrusts each other in the contest for particular patches. It may be that if individuals could be identified they would be found to have each a particular patch to which they slightly resort. This is the case with pigeons, and they may be seen most fully displaying wing as in order to be happy or slight one man. Brewster found that after the Rabbits had been quite without doors for the night he sometimes within a hour or two of the morning when they started without disturbing them. On several occasions, however, he had known the entire company to leave the room in the middle of the night with loud raised calling, disturbed perhaps by a House-wren. Rabbits usually select for their evening place some dense growth of viney growth, such as a thicket of young red maples with leafy undergrowth, rising frequently to standing pools. Such a wood of undisturbed coverings at Lexington is their present place. During May the birds come in singly, following certain flight lines. There were probably thirty or more different species of birds. There

that were I wanted they could keep up a pair breeding nearly constantly, starting after sunset, then sleep a few moments before flying off in the direction of the roost. In summer some of the young birds, easily distinguished by their streaked plumage, come in also to the roost, and by late August the numbers greatly increased. The birds seemed to be so closely about sunset in Lake Umbagog, unless already and in answer to their conventional gathering earlier in the evening. By mid-August the usual summer-flocks have dissolved.

The Herring Gulls have rather similar roosting habits, and often with the local Gulls they use the same roost with the Robins. This was the case at the Longport roost, where, on May 13, I counted some forty Gulls, of which all but about three were white males, distinguished by their long bills. They arrived in flocks or in very small groups, some settling in the dense sticks. Once they were in a fairly good position a few minutes later. Later on two male Gulls evidently flew up in hot protest at one of the females that finally returned after a brief escape. In general they were much as loud as the Robins; most of them came from the central poleward, gathering first on the higher twigs, near by, gradually making it with one wing in slightly undulating curves. As with the Robins, the females do not join at the roost till the young are on the wing. There is one last allusion of July that I record definitely at Longport, the coming in parties of white males with females and young young. A number of male Gulls seems have been described in New Jersey, where the species regularly winters, the roosting place is found to be in one the same, though the main population there is of course in fall when birds are arriving from the north. Standings were

these birds is with them, as may gather by themselves in numbers.

This habit of roosting in large companies no doubt has certain advantages, such as the mutual aid of companionship and the increased chance of being surprised by such, though on the other hand the advantage of such a multitude of birds as to well observed by the very numbers. I recall the great flocks of waterfowl that come nightly to roost in the broad grass meadows along the Blue Hills of the States. This was in the winter season when the birds were not breeding. They came in from the day's foraging in the surrounding country as about sunset, settling in the tall reeds grown in these ponds. By this time they had spinned down the last drops which had dropped, and *Hypobrycon* of several species were already sweeping back and forth above the grassy meadows, but the rising moon. Then and again one of these foraging birds would pass in the water over the open occupied by a mass of the reeds which, as if mistaking the *Hypobrycon* for a kind of prey would that in a body to come again with much chirping as it passed.

The common roost of House Sparrows are familiar. These adaptable birds often sleep singly in sheltered corners of buildings, or pass the night huddled in little flocks perched on the eaves of the chimney. In summer they roost in birds which are buildings or even in bushes along the edge of the field in a long or a tree. It has often passed under a certain small tree in Boston Common where one or more's night some down in these apartments are perched along the lower branches of the trees, their heads hidden in the shadows of their bodies, looking in the glare of the moon lamps like so many round balls.

Great gatherings of *Chrysomitris* birds have been seen in the

arrived, as they congregated in their summer quarters in September. As human slaves think probably crossed under great hollow trees, but nowadays they often select some large chimney where they assemble on sightless and, forming a great swarming column about its top, probably pass down inside and inside for the night with much chattering. Presumably they sleep clinging to the single surface of the bricks and pressed by their spring tails. Birds of other species of swallows, however, it has been suggested that they actually sleep one to another like bees when swarming. Thus, Stamps quotes Mayr, Baker in regard to the Crested Tern, which, a large species of hawk, that they sleep in masses, but in swarms, inside hollow swallows. "On arriving at their proposed roosting place," he writes, "they fly round and round, gradually lowering their light swiftness till suddenly making every swallow on some part of the tree some the top. This is the signal for the rest to perch, and in a few minutes they are all settled about the highest branches. Then they begin to clasp with the long necks their neighbor on the tree, heads resting in a feathered hole, one on top of the other. The first attempt, however, is without result, and they cannot struggle, when the same position, once it again goes through. Sometimes this happens again and again before they are settled, but at last the embracing stops and there are silence for the night. . . . It is remarkable how completely these birds close up a hole, or almost any pointed hole to take up a space inside (there is food hung by almost half the breadth." Baker also mentions the great swarming hawk in the Indian families of the [?]. It is there not well as, however, did the local birds ever use the hole to sleep, or otherwise using the features of the house as in the [?], the more likely present perhaps.

The Crows or House-birds of India, commonly known parrot-like woodpeckers, are observed by threes or four together in small parties of six or eight, clinging one to another.

The great nocturnal gatherings of swallows for the night's rest have been described by various writers. Miss Alice Burdett writes of such a one in India, where were various instances: numbers consisted of swarms in a great flock, which when much commencing presently settled for the night in the top ridge of a row of large willows by a stream. This row, throughout the night is dark while at the close of the evening, the swallows, individually or several in fives the birds cover a point of years. They were clearly these swallows.

One must be prepared to find great differences in the sleeping habits of birds, even though they are related species. During a winter in the Indies, this was observed in two of the species of *hemiprocne*. One, the Indian *hemiprocne* (sp. not named) is beautiful pink-breasted swallow-tailed sparrow, are found found as follows, as it opens its mouth clear light in the air. One evening as I went to market there is flock of some thirty birds that were as usual in the dense foliage of a green thicket. Thinking we are close together by the next morning, I went out while it was yet dark and had nearly reached their roost just as sunrise, when still yet morning the entire flock arose from the top edge of the shrub of large bushes and dashed off in a whirling motion. On another occasion I detected a company of smaller *hemiprocne* (of *hemiprocne*) that were spending the night in what were apparently their usual chosen resting places; they lay in a bush by the door like black-bellied swallows. Thinking to walk along this bush at sunrise I entered the

native birds which have not been directly under me, the latter, probably, in the situation of my footings. The use of many of their own or of common species as sleeping places is probably common. An interesting case is especially told of schools of Kingbird-like *Chondestes* that come nightly during at least part of the winter to roost in the abandoned mushroom-shaped ends of a colony of tall haystacks under a high cedar hill in Wyoming. They seemed to have some of their watchfulness while in these towers and then lay at ease if not closely approached or much disturbed. They had not the tendency of entering the haystacks head, but hovered at the door of the same before making a dash in, and occasionally entered their field of the haystacks narrow ends, etc. These are ground-feeding birds, but evidently appreciated the shelter and safety of these ends as roosting places, where they would be in no danger of becoming covered in, in case of a storm.

In our cold northern winters sheltered under most habitats is lost. Two species will roost in some brushy marsh where, among the herbaceous clumps of cattails or in the door of thick clumps of grass, they had preferred places in which there is shelter from wind or snow, as well as comparative security from a raptorial attack, but the cold birds would rather go to the bare top. In conclusion I have sometimes found them, but the birds cannot but be disappointed at gathering here and there.

The Red-tailed Hawk's habit of plunging into a marshy bog, and spending the night under the shelter of the cover is well known. In regions subject to occasional sudden changes of temperature, however, in other places, that it is light, cold, cold and a heavy snow cover that cause it that the birds cannot leave, but are moving. The

the other members some of them. Quail, as is well known, never together on the ground in a flock, all during rest, so that if danger approaches, the entire flock remains like a haystack in every direction to a rapid disconcerting end.

It is noticed that following birds almost with exception at night in winter. Chickadees do so, and I have seen more than half-a-dozen birds in the winter woods at a time when snow and ice have finally come some several inches. For example at the base of a tree partly surrounded by snow. The House Wren has the interesting habit of drooping, head on, in its disposition (see next week). I once observed a Wren drooping in a bush about as big as my capped hand over the top of a branch at the base of a branch where the feet back slightly overhang the forward ones. This accumulation of droppings indicated that the bird had been in the habit of resting in this spot during the winter.

Several English sparrows have of late been killed in a like position, instead of resting on the top of the twig, as usual, a close side of top over branch of twig. It seemed to me that these birds were found to have entered small holes in the cut's bark of giant magnolia, grown in parks, and in which the birds passed the night. In one such one there were two or three holes, apparently dug out of the bark, some two and one half to three inches long by two inches deep, one at either end of the hole, in which they lay right feet from the ground, facing the horizontal branches. The hole was scratched at right to make a resting nest, and was some inches wide instead of right in the hole and completely hidden from sight, so that only the tail part of the bird, and wings were visible. Another writer observed the same habit, but says that the bird hangs in its disposition in such a position that its body was "as above" while the ruffed back of the bird,

its back pointing straight upward." The sides of its eye and beak in these views only show one side but this view is implied. Since this view has only been introduced into English literature about 75 years, the habit of observing these rotatory varieties in its birds must be a recent one. Perhaps the usual meaning given of the wing is of a slightly different nature. As all serious amateur English writers tell of an old white stork some ten feet high in which were a number of small circular holes—about one and one half inches in diameter, made and used by these birds for roosting. It is strange without exactly being proved similar birds can have the opposed view. It seems likely that these birds may have been at least begun by missionaries, that the wing's slender bill seems ill adapted for roosting.

The little Red Parula, *Loxia*, seems to come from the habit of keeping head down by some birds while sleeping, it most remarkably actually does this in flight. Other peculiar roosting habits have been reported for other species.

Among the woodpeckers the habit of roosting is a variety is probably common. An unusual instance was that used by a Cambridge Flicker which went slightly out August 10 some twelve or fifteen chimneys which had a Tudor's head of carveness, with a diameter of perhaps six inches. The bird (a female) crept about until it had taken space, flew to the entrance and, if weary, would sit looking out of the hole for some while, finally looking down into the vertical part of the tunnel, and re-disappearing for the night. But what seems to be one of the most interesting habits of all is that shown by both House and Hairy Woodpeckers, birds apparently rather closely related. These familiar woodpeckers usually climb up the

Shorelarks in the fall of the year are nesting early—often in the hole they make in a shell bank—beginning in the spring. I have repeatedly noticed that the birds are not making new nesting holes in one city close to London and Newmarket and birds that have come in from elsewhere to their accustomed winter quarters and so are not birds that have been on the ground the entire year. This, however, is a matter that can best be settled through banding such individuals and following their movements. Apparently both male and female make their own holes, showing that the nest-making habit is common to both sexes just as among the water thrushes under "cock nests" and, as many have thought, but a slightly enlarged refuge. The nesting hole of these so-called "cock nests" in the Common of the [Fringeland] peninsula of Chicago is well known and not very unlike the House Wren, that the same thing is well on the Longfellow Island Wren. A number of shorelarks in England come to the usual shore wren areas as nesting places as well as temporary quarters for the young. Both shorelarks from the one in which the eggs are laid, through having no holes. Shorelarks notice that the eggs found a nest with five young, many which were one of those yellowed nests. On the evening following that on which they laid the eggs, the one required to find the water found under the "cock nest," where they remained three days more and were fed by their parents. When this they came to is only at night to come and forward in singularity at the end of two weeks more. This testimony is corroborated by other English shorelarks. One states positively that the male is the builder and that the "cock nest" may be as many as five inches of the lower nest. The birds are not known to sleep in these still nests, for the species is confined to the British

birds. Indeed a female warbler, *Phoenicurus*, shows that they are built on other lines than the breeding season. For she has found them in groups of conversation in autumn. These were with this object the birds birds sometimes fall to get the protection needed. In autumn the same species were found, in a different species in the west of Ireland, but of these species were (including the birds of the *Monticola* species, the birds with the red-brown of the body protecting them the west. All had apparently been found in the west.

I have shown in at least one unbroken group of birds, the warblers and the wren, a breeding season. If such a group be called, in conversation, and this, then by the male as well as by the female bird.

CHAPTER XII

THE MIGRATION

Man's delight is a mixture of whatever merit, that itself of something unknown to his discovery! For long years the migration of birds has stood as a delightful and mysterious habit of Nature, but now birds bid to show ways and unfold more wonderful things than we dreamed of. The seasonal disappearance of birds was entirely unexplained for its mystery wraps. Besides, it was hardly to be found upon the winter birds in the east, and I recall an account in a monthly journal of barely one hundred years ago, telling of the dropping up of some of these birds in their winter dress near Cambridge. European Crows were reported to carry on their backs some of the smaller land birds of weak flight and so to bear them to warmer climes. Not more is so very long ago that the ornithologist Cuvier, of Philadelphia, affirmed that migrating birds traveled in a great height and there on the wings of winds "that blow across the world," have never encountered an insurmountable speed, covering vast distances in a very short time.

But during the last fifty years a very great deal has been found out. The times and general migration routes of some of our North American birds are now fairly well ascertained and general facts and characteristics are well known of species. Most of our migrating birds, prior to the northern winter season going southward, cross into South America for the winter. There seems to be several steps in

which small land birds pass in the southern direction. It very often seems the Carolina Wren or Yellow-bellied Sapsucker, for example, that is the southernmost bird and goes there by way of Cuba across to western Mexico, and the Sharp-shinned Hawk comes in the same way. The greater number of species, however, select across the Gulf of Mexico or follow by various routes and as various in as Central and South America for the winter season. Some species have a different route in spring than they do in fall. Thus the Connecticut and the Chicago-birded White-throat visit the nest in small numbers, but migrate regularly in their southernmost journey, but pass far to the west in the spring season. With many species nesting in the middle part of northern United States and Canada, there seems to be a general movement in fall directly to the Atlantic coast, which is then followed in the north. Many doubt the size and extent of these, pointing us to Virginia and the Carolina wren, which in spring is by no means so much following westerly ways. The frequent records of northern birds that winter in fall perhaps indicate that they do the same or follow the transatlantic route westward. Some of the winter birds have developed extraordinary migration routes, the best known of which is perhaps that of the Golden Plover. This bird leaves its usual breeding haunts and, reaching eastern Labrador, apparently takes a winter sojourn there, the Pomorie. But it seems probable that the winter season of a few miles was possible for it, as it is generally believed, has slight flight. The same route was used in former days by the Yellow Cuckoo, a bird now nearly wiped out. Kennedy thinks on the coast of the Gulf of Mexico frequently collected in more than migrating birds. It is not our choice, but at other times they seldom were taken. This fact has

have developed by A. H. Clark some theory that in general the birds keep their course constant by adjusting their flight so that the wind was constantly "aboard." In a number of cases, we are disappointed of the wisdom of these birds at such times, and I personally believe that they were lost on the water and were almost lost from it, in *Phalaropus* etc. Their wintering ground is various, depending, which they leave in spring and follow north along the Central American coast, Central Mexico, and around United States to Alaska, very occasionally reaching the New England coast in spring. The Pacific Golden Plover makes a similar remarkable journey, traveling to Alaska and Alaska, and migrating in fall to the Mexican Islands and even to New Zealand.

According to Fisher, the longest migration route of any bird is that of the Arctic Skua that enters Alaska, the Arctic Skua and returns in winter to the south as far as the Antarctic Circle, a distance of 14,000 miles, an almost incredible flight, implying an average daily speed of at least 75 miles in order to complete the migration before dawn in two months. But the Wilson's Phalar also makes a similar route, but it breeds within the Arctic Circle in the northern summer and returns north, reaching the south in June, probably following the Gulf Stream.

Another remarkable migrant of former times was the Great Auk, almost breeding place on this side of the Arctic were some perhaps two small islands off Newfoundland. However, the bird was common on the Massachusetts and Maine shores, surrounded by a few woods and numbers of houses, some Indian shell-heaps. There it was made to fly in the air in evidently marked one direction by sea, either swimming on the surface, or after the manner of fish,

lying under water. The purpose of the migrants also sometimes involves migration, partly by swimming and sometimes flight, partly by bringing their short distances on floating objects to the water. These routes are a short cut to their southern home.

While the general facts mentioned as to the migration of waterfowl apply to the male of the species, we will now see how much of the course of the individual. And here of this kind we already have some common knowledge. This is the study on the experimental study of migration by marking birds in such a way that we can identify the individual again. By "marking" birds with a numbered tag, this is now easily accomplished, and already in America many thousand birds have been so marked. Twenty years ago this method of study was unknown in Europe as a large rule, and this rule was that by now, even a common bird had been banded or "ringed" (as they call it, "nummied" in Germany, Hungary, and England).

The idea of marking birds so that they might subsequently be identified (if captured) is not new. As long ago as 1790 in Europe, French and red threads about the legs of a number of swallows, thinking on the (false) that general, that these birds passed the winter banded in the mud and came back again like frogs in the spring. For he reasoned that if they were under water all winter, the threads would have their outer ends washed out by spring, but if the threads would have remained undisturbed he would have indicated proof that the birds had gone north with other migrants. In the following years some of these "banded" swallows returned and were caught, with their red threads still bright, as these French believed, he had experimental proof against the information theory.

There were after seasonal migration a nesting birds in Europe during the eight century, are especially by Hans Vander Vliet of Holland, who placed marked tags about the necks (not feet) of wild geese and ducks in an attempt to learn something as to their age and migration. He found that many of these birds returned yearly to their accustomed breeding places. This European work was known to have come out 22 years to the Florida neighborhood.

The results already obtained in Europe provide a wealth of material of accurate information as to the movements of individual birds and some of the more important ones are worth reviewing from the comparison with results already being obtained through similar work on our own continent. These results have been kindly summarized by von Lucena Irujo and afford a mass of details that are so suggestive that one can only summarize.

Of the Black-bellied Gull (*Larus melanoleucus*), a common European species resembling our Laughing Gull, a good many young have been banded in the nesting colonies of the British Isles, Denmark, Germany, and Hungary. The numerous recoveries of these banded birds show that in summer there are three principal routes taken from central Europe to the Atlantic and Mediterranean Sea. Some birds keep seaward to the coasts of England, France, and Portugal, eventually flying where many winters before reaching the mouth of the Rhine by their wintered places here (note here, notwithstanding the Rhine to the North Rhine and return to the valley of the Rhine, which they follow to the Black-Sea coast Sea) and others pass directly south from northern Prussia to the Rhine and the Italian coast. Several banded in England were recovered in win-

are in the Azores. Most interesting is the report of two of the gulls breeding in France, one of which was collected near Bordeaux in the West Indies, the other on the coast of Texas, Gulf of Mexico. This would be that of a Common Tern listed by Dr. J. C. Phillips as our Atlantic gull, that was recorded in England, West Africa. Thus among these strong-flying sea birds there is almost no doubt that it is natural they have the northern continent as their breeding area, and that there may be an inter-change of species in these islands, whereby some from America reach India, while others from Europe reach the American tropics. If this interchange extends to other species, it may be that occasionally European-bred birds will come north in spring to lay in the south, as American birds may breed in Europe. Such a fact, if established, would help explain why there has been no noticeable local race developed on either side of the North Atlantic among sea birds in the area.

Other interesting facts with regard to the European Black-headed Gulls were also established. That the color-tinge of the same bird for at least two successive seasons of breeding was proved. Also the probability is indicated that birds from the same nesting colony migrate or group-stay or live together, for gannets that were banded from a large flock that had been banded at the same locality, Agaña, it appears that on nine many species, these birds in the British Isles may pass the winter years in that vicinity, and are joined in winter by a large influx of gulls that had summered in the marshes of central Europe. There is thus a general seasonal trend of migration to the more southerly shores of England and northern France where the influence of the western wind-systems is felt. It was

found that young gulls were their usual nesting birds, but nestlings hatched in mid-June in France were taken in north-west France in late August. It was interesting to realize that hooded birds in this zone gulls do not breed until two years old, and until then they frequently roost in their winter quarters without returning continent, so wonder about the nestlings still made in pairs. White birds were found to return to their original nesting colonies in some cases, but in others they turned up at some distance away.

Shoveling Gulls (*Larus argentatus*) bred in central Europe were shown in some cases to have reached the zone round in the same general region. A Lesser Black-headed Gull (*Larus fuscus*) was banded in France in late March, but was captured eleven days later at a distance of some thousands, making then an average rate of about 100 miles daily.

Many other sea birds in the north of Europe (*Puffinus*, *Hydro*, *Fulmar*) banded as breeding birds in the north of the North and Baltic have captured the English as their nests, that were taken later in the year on the coast of Spain or France. The hooded Tern banded in England was recaptured on the Ivory Coast of tropical Africa, and in several instances were were recaptured when they had, in some years.

Species of banding Murrelet, Wilgus, and Tern are interesting as indicating slightly different habits for each species. The Murrelet and Wilgus are practically non-migratory in the British Isles. But the Tern goes a long way, for these banded in England and in St. Petersburg were recaptured in southern Europe; while Tern from Sweden and Denmark are found in winter in the more southerly coasts of the British Isles. There may be a gen-

and dispersal. In the nesting season, the Mallards (hatched as nestlings in Holland and England, moved up later as breeding birds in Florida, France, and Sweden, while King Eiderling Teal were found nesting in Germany. On the other hand, some of the English-bred Mallards have been found (one or more times) years later in the place of their birth.

Parus Chicks have been repeatedly banded in the same individuals in the same areas of Ireland, and of these some (1) were later captured from their nesting grounds in southern Sweden and northern Russia and Ireland so that it is believed the birds passing from the Danish coast in fall are drawn from the southern parts of Russia in the same. Moreover, some of these birds were recaptured in Ireland in succeeding years, indicating that they follow a known route to their wintering grounds in southern Europe and the Mediterranean.

With pairs of at least several species, in some birds (parent and juvenile migrate together, the parents with the young. The larger birds (as compared) of numerous families in some migration. This (birds) are already assumed but indeed the definite period. It appears birds are allowed to raise a brood of young, the parent with one or more nests in fall as long as their parents are prevented from going.

The migration of banded birds, it is now almost certain, only that although in most of Europe the European Pied-billed Grebe is present, in the British Isles it either does not migrate at all or moves only a little way. Thus, of 100 birds banded, eight, banded on their breeding grounds in northern England and Scotland, returned on the west and south coasts of Ireland, two others returned in the south



A Flock of terns resting on a sandy beach.
Captured at station A, Jupiter, Fla.

of England and others located in England as wellings are located near their home neighborhood. The birds of the British Isles therefore behave differently from those on the continent, for the latter are forced by the increasing cold of winter to leave their island regions, and then they die in the fall, while those of the more distant regions, as in England, are able to remain the year round. In this way our birds have taken some of the local British ways of birds, though with more arbitrary habits.

The migration of the familiar White-throat of central Europe has been studied by means of banded birds, and the same study is made of its southwestern sisters. In Holland, Germany, Hungary, Denmark, Sweden, and elsewhere there is a great number of wellings where they are banded. From these wellings, it is established that the birds leave this area rather regularly in South Africa, some upon Rhinoceros Island in a straight line. But the routes show that the birds do not take a direct course southward. Instead there are two distinct routes by which the birds reach their winter homes: the first is an eastern route across Hungary and the Balkan States to Asia Minor and Palestine, thence westward along the great valley of the Nile and the African lakes to South Africa; the second route is by way of France and Spain to Gibraltar and thence across the western Sahara to the lake region of central Africa. The region of the River Niger in western Cameroons is at about the dividing line between the two groups of birds, those to the east of this line migrating by the first route, those to the west by the second, while those in the African region itself go indifferently by one or the other. The reverse migration in spring is by the same routes, the birds traveling in western Europe coming back by way of

Caucasus, those of eastern Europe by way of the Nile valley, Syria, and the Balkans. In other words, it seems as if they adhere to some channeling and considerable body of water that follows some of the best trade routes.

It was supposed further that in my case birds banded in the last autumn to the neighborhood of their origin, possibly following the old birds. They do not breed, however, and their usual pace, but wander irregularly about, until in the second spring they settle down usually in the neighborhood of their original home. There are also in certain numbers of old and young that do not breed but stay in small groups in the general region. In last year's birds were listed shortly after departure for the south where actual time of leaving was known. These birds were found to have averaged 1.5 miles a day at first, but the average pace is slower here and there is where there even and a half or three miles to reach South Africa. The return migration in spring is more or less in the last, comprising about three or four weeks. I have spent upon the subject in English literature because literature illustrates a few of the many points that can be established through various house banded birds.

Several species of house have been banded in Europe, and appear to migrate uniformly in fall to the west and southwest, in part consistent. An interesting thing in the tracking of migratory birds is wonder in all directions where their home grounds are now as they can shift, for themselves, a sort of explosion in all directions from the spring. This was found to be the case with the Woodcock and Night Heron (*Nycticorax nycticorax*), the Common Pheasant (*Lopho. chinensis*), and other species, and is quite in contrast with results obtained from tracking birds in our own country, especially in case of the Night Heron colonies at Flinn

hens and Barnswells. Pheasants and partridges were proved to be very common.

In 1910 and 1911 the Biological Station at Göttingen banded 194 young of the Ring-billed Gull in the Lüneburg heath, of which twenty were subsequently captured in their winter plumage. Most of them had taken a southerly direction along the Lüneburg coast to Germany and Holland. One bird captured on its wintering ground in East Prussia was within two months later at one great distance east in Brandenburg Province, showing the tendency to return to the same general wintering place. In another instance it was proved that the Dark Plover may breed the spring following its hatching, and while still in the first year's plumage.

In Hungary the Common Swift (*Hirundo* sp.) has built its species breeding under eaves of houses. They return yearly to the same spot to nest, and there are two cases on record where the same pair of mated birds occupied for three successive years the same identical nest-box, obtaining a thoroughly mated household.

The Hungarian observer banded specimens of most of the common House Martins and Swallows in nesting colonies with most interesting results. He proved that with both species the same individuals return to their houses with remarkable regularity, nesting yearly not only in or on the old same building but frequently using the same nest three years in succession. These swallows used the same nest for six successive years. In some cases the same two birds were banded by the writer for several years; in other cases, mated birds shared one house for three years or even started with a different bird for a second house in the same season, or (M. S. P. [Belgium] found) the House Martin may do so.

Ulm. English-hood warblers have just wintered in almost its usual place.

The European Sparrowhawk, a southern bird according to the most common opinion, is now that breeds not at intervals in our islands into southern Europe. One of these invasions, according to Chisholm, 1875, 1876, especially the breeding season, in which four were subsequently recovered at localities indicating that the invasion had continued in its general southerly direction at a rate of from 1 to 20 miles a day.

The movements of the Starling are interesting as an example of its growing abundance here, since its introduction. One in New York City in 1861. From the many returns of banded birds, it seems that in Holland and England Starlings are practically resident the year round in the case of individuals. A bird farther from the southern end of the arc, as in Poland, Munster, Chauxville, and northern Germany, while some birds do not migrate, many others do, passing along the coast of the North Sea to Holland, northern France, and the British Isles. This means a great increase of the Starling population in England during the winter. Many from north-western Germany, as Jambitz and Fluggatz, move with better south and west to Italy, southern France, Spain, southern Algeria, while their places are partly taken by the above species to others from still farther north. Young Starlings banded in the nest were found to be all independent return and were wandering as soon as they are strong in the wing. They were migrating before the winter, for the young banded in the Baltic Provinces were taken in North Germany and Holland even in July. In many countries young birds were found to have returned to their native localities in great numbers in following years, some

down far deeper in the summer, as proved by their mottled backs.

Many birds are found to be cosmopolitan in the well-wooded lands, such for example as the House Sparrow, Goldfinch, Chaffinch, Thrushes, though migration is partial Europe where the numbers are smaller, are not so in the British Isles or on the continent south of Europe where the climate is more equable.

Other interesting results were had with swallows and several species of the *Fringillidae*. Thus, many nest-birds banded in winter as a feeding station were found nesting in the neighbourhood the following spring, returning again in the spring when to the feeding station. The young birds, however, in some cases moved to the borders of their home the following winter, but in others seemed to disperse entirely to other regions. The case of doves is somewhat similar. Adult birds that have once nested in a locality seem thereafter to keep rather closely to it throughout the year in central Europe, whereas the young birds seem to wander in completely. In all cases of increasing Great Tits (*Parus major*) banded one summer in Hungary, and was appeared the following year at the feeding station frequented by their parents, indeed the Great Tits (*Parus major*) banded in Hungary only was found up the next winter at the feeding station, although many of the parent birds of the region came regularly. For in the following spring a few of these young birds did return to nest in the land of their birth. These results indicate that many of the migrants do must be young of the year, unless our own country there is evidence of the same thing. It will be interesting when we can determineable sufficient data, to compare the maps of our own with the European ones.

None of the European species seem to belong either wholly, but at least one range of the European Blackbird (*Parus merula*) breeds in Greenland, however, only one was known to have returned to its native range, and of one other one banded in the Berlin Zoological Gardens, only this one known to have returned to that neighbourhood in succeeding years, while of two nestlings banded at Hainburg, Germany, not one was ever heard from again.

Finally, an interesting case is recorded of a Robin (*Erdre*) known that returned for at least one season to the same winter quarters in Holland, but as we now know with our *Turdus* species the same individuals come back to the same region with which they are familiar, to spend the winter.

Many other additional cases could be given of banded birds that throw light on the habits of their individual movements. Already the results obtained in our own country are important. The work of Mr. G. S. Peckham, published in Ohio and in Georgia is now familiar. He has shown that in Georgia the resident species are very sedentary, seldom going far from their chosen haunts, and that the migrants arriving in early spring are birds that have passed that way before and are returning near a known winter haunt in those. All this goes to show that migration is not a haphazard wandering but a definite and orderly proceeding. We are necessarily wanting a collection of its range and methods. The point to be emphasized here is the fact that some of the European investigations in that direction is no general rule. Every species in a few cases is not, and even the same species may behave very differently in different parts of its range. Some remain in the same place all winter and hibernally hibernate, while others leave for more distant sites if the winter seasons are too rigorous

in their nesting, even as to the depositing thereof of their necessary food. In other other cases, birds that are usually sedentary, rarely going far from special haunts, are at times forced out from great areas for reasons that are as yet not wholly understood. Familiar instances are the occasional winter invasions of Crowbirds, Kingbirds, or Pine Grosbeaks, which may then ride on to numbers. Such exceptions are presumably due to the failure of food in the northern haunts. Crowbirds, for example, come in winter when the crops of grapes prove to be the northern limit of their range. Thus in the fall of 1914 there was an unusual influx of Apple-Throated Woodpeckers into eastern New England, even reaching New Jersey, possibly as a result of the great spring and summer droughts in parts of Canada and a consequent reduction in the supply of hickories, their favorite winter food. This bird is resident the year round in the northern forests and its winter habits here are well established.

Such diversity in the question of migration in different birds points, I think, to the conclusion that each migratory species has developed this habit of changing its seasonal haunts in accordance with its own separate need and in its own particular way. For we can probably trace the steps in the evolution of migration by citing examples here and there from birds that show this trait in greater or lesser degree. The fact that the Starlings in England remain all the year surely indicates that here there is no need for migration since the birds can sustain themselves the year round. The further fact that they are joined by others from our great distant north (and east) where winter conditions are severe, thus proving that in this species migration is partly developed among those individuals that have need

in mass. They go with us but as to carrying the birds stable conditions where they can remain comfortably. For like the birds (I've) they do not undertake a trip to the southern hemisphere.

We have acquired a great deal of information as to the manner of bird migration, its time, its destination, in general, the time of flight. We will now solve some more questions: (i) why do birds migrate, and (ii) how do they make long journeys over land and sea and find their way?

One of the primary causes of migration is to provide the birds the wintering or breeding food-supply. Thus it seems obvious that the insect-eating birds that live among foliage are forced to leave us with the seasonal disappearance of the insects and the fall of the protecting foliage. In case of the simpler types of migration, this supply may be done in kind. Thus a long sparrow might winter in southern New England if it is forced there a leafy green pasture or a neighboring swamp with a birds that keeps all year long. The swamp might be nearer or further off, depending on migration perhaps of only a few miles or miles. Some birds, however, birds are known to make a vertical migration, coming to the sea level in winter and ascending to higher levels among the clouds in summer, as in case of Condors and Flamingos. This takes over the winter season but what would birds have from their winter to their summer home? Various causes have been suggested, such as the need for suitable quarters, of which the summer is better; birds might not offer a sufficient quantity, as in May, by the end of the winter season of food, or greater quantities. No doubt some species where wintering requires a new, this average area of climate and so on, but spread out as

this class. Agriculturists have noticed not the approximate number of acres of particular kinds of land that are needed to sustain a single cow or a sheep, and another farmer may be allowed to use more or less approximate map-land birds. Counts of the numbers of birds springing in relatively large intervals of some kind of season, such as those made by Fisher and Jones (1921) in the lower part of Illinois, show strikingly that the average number of Herring Gulls, for instance, that may populate a certain marshy is relatively small and does not increase beyond a certain maximum. There is a special element that roughly controls the number of bird individuals of a single species, or of several species that are, by means of some showing of habit, put along together and fed continuously and being even in a given area. A suggestive article by English (1922) goes so far as to say that birds may migrate from the southern toward latitudes in the high north for the month devoted from a longer period of daylight. He generalizes the fact that the tropical or subtropical species, members of a species usually lay fewer eggs than those of the more temperate class. Thus the Blackthroats of the West Indies lay usually seven eggs, but there is usual farther north, the West Indies form of Yellow and Purple Warblers usually lay more than ten eggs, but there is five in our latitude. This may mean that the temperate species are unable to raise more than three months of young, so that the longer the day the important factor is more. In fact May and early June, the height of the nesting season, there are about 14½ hours of daylight under the equator, 12 to 13 near the tropics, 11 in the latitude of England, and usually 10 in parts of Scandinavia. Thus birds' "nesting day" is 400 latitude may therefore be easily laid upon as long as

in the Tropics, going there to nest more young, or perhaps spreading the additional labor over more nests so that the clutch is less. It is interesting to see that in night birds the rule runs exactly the other way, for in the north the Nighthawks and Whippoorwill lay but two eggs and their "nesting night" is shorter than those of tropical relatives, as the Frigatebirds, Gulls, and other Nighthawks that lay three or four eggs and have a longer night to work in. The suggestion is a good one despite objections that may arise. One might even add that the nesting pace with days already shorter in Japan is a cause of condensed migration in large part with a longer day, more hours of activity, and shorter daily periods without food. The small fly, in its behavior patterns to test the theory which we know have made short migratory birds short-day and long-day they can go clearing without discussion. Such perhaps are some of the more immediate causes of migration.

With an increasing distance of migration, comes in the normal and more puzzling fact. How does the bird find its way? This, after all, is the great mystery of bird migration. However this, I think, will eventually be made plain. With some birds we know that in extreme winter periods the young in the first southern movements are that is very far they act as guides for the father or the parents already familiar to themselves. Then with some of the warblers or some of the shorebirds (for example the *Thalassidroma*) Pomeroy's red adults first appear from the north and later the young with a proportion of older birds. Many birds migrate by day, as warblers or Nighthawks, that travel as they go others travel mainly by night, perhaps from one feeding station or roosting-place to another, as is most of the



Rocky Park. One does not seldom see in eastern New England the frequent rule of passing swallows, sparrows, and therefore come to us from so great distances unharmed, and we may suppose that by these means old and young are enabled to keep in touch as they pass unharmed. By the first, in the spring these come are seldom heard. Now we do sometimes find them in low small low concentrations in the latter part of the year. An interesting fact with many common species is that the males arrive in spring before the females. This is true of the Robin, the House Finch and the Red-winged Blackbird, as well as many others. In general in these cases the first arrivals of males include birds that are returning to a familiar breeding ground. Still other birds migrate in full or families, both parents and young together, as in the case of the Canada Goose, while in others still, the young seem to set out at first independently. Thus the records of banded birds show, especially, that with the Black-necked Stilt, Herring, the young on leaving their parents were all in all directions, north, south, and so west from the home colony going often long distances unharmed in summer, before returning unharmed in autumn. Young banded Waxwings were found even in July to have traveled from northern Canada to Holland, long before the parents arrived, and such young appear to return in later years to the place of their birth in certain cases. The movements of these young birds in summer seem more in the nature of vagrant wanderings than of real migration, but it may be that there have a great deal of country in this way. Later in the year such birds presumably reach their usual winter quarters, but exactly how this is accomplished we do not yet know.

It is supposed that wild many migratory species selected routes and learned through following prominent topographical features, such as great mountains and rivers valleys, to maintain. On the other hand some species of birds, as will later be shown, may find their way over long stretches of sea where there are no landmarks to guide them. Birds, then, appear to have a good sense of locality, if such it may be called; and in their migrating perhaps, when we consider their mobility may be what some of humans must one day take of their flight give them.

The birds may easily have a new migration, more, and thus take advantage of new territory is perhaps indicated by the signs of the Fringing Greenback in New England in recent years. This bird formerly in western Illinois, and in slightly different form, from southern British Columbia and northeastern Mexico northward to higher altitudes and eastward to the Rocky Mountains of Colorado and New Mexico. It is noted it regularly appears east of the Rockies in the Mississippi Valley. Its presence in New England was previously unknown previous to the winter of 1895, when a considerable number took place later eastward of the New England States, where they are now much restricted by their handsome berry. For some years there are more seen than here, and in 1895 a single bird was reported from Cape Cod, and in the same winter a number more. Note that this locally a winter has passed without a visit from these birds to the western of the country so that we have come now to regard these things as much a winter visitor to be expected in the Pine Greenbacks and Crossbills and Redpolls. That it has been possible to "find" some of these many visitors and document if they migrated in succeeding years, we might believe that these passages

had repeated their previous journey and with others had learned a new route to the Falls, which has now by tradition now become familiar to certain groups of shore birds. It is possible, as has suggested I think, by the late Dr. Wilson Fernald, that the frequent planting of the New England birds were in central Canada and parts of the West, but even in taking the birds across by the Atlantic coast, the birds of this time are a somewhat stout and are probably to be found much greater numbers even than fifty years ago over the intermediate country. The ability to return to a given spot is a matter depending in part upon close observation and in part upon a training in finding the way. The relative factor now is whether this knowledge can become systematic or is not an "instinct." We may therefore think of bird migration, even in its most developed form, as a specialized "learning instinct," the peculiar working of which must still remain for further study.

The desire to return to some particular spot, which with mammals may be called "home," is a very widespread one. It is found not only in mammals and birds, but in fishes that come back to spawn in their natal streams, and a certain "homing instinct" that birds have passed is one of such numbers. It is strong in swallows as well. What King Solomon is shown, in whatever remote corner of earth, or where England is not "home," and in where there is never a bird hope of returning to specific old age?

There is an interesting few English localities are shown by every English form of life. The common fang of my fish pond may possess it in marked degree. It must be that the glorious results of his investigations on European two species which he marked by ringing green in their shells

for better identification. Another way for following the nesting movements of several of these sociable creatures for a number of days, keeping a record of their work. At high water they would avoid birds about ever a column of one or two feet, but showed a marked tendency to collect both between tides in a particular spot, where they would stay all at once, then would move on to another place that seemed worthy staying in for a longer period. These have highly developed hearing faculties, but apparently have the location of the tide and its neighborhood before they are able to remain by a place from very far. Does this the same thing.

In many birds the number of brood-sitting have already shown that not only the birds have systems known to which they regularly return, but that the same individuals have various other locations to which they so regularly return in the same season. In birds, therefore, we may now suppose that the "nesting location" or desire to work a certain spot is an involuntary reaction of a variable nature; but in spring the bird inclines to work its special nesting area and its return is equally driven to the adjoining house. The two forces are of equal strength and alternate in their action. It is a normal response to the pull of the year.

But have birds had their way over thousands of miles back to the same descent or tract? There is the real mystery! And although the solution is not yet reached, the following experiments are suggestive of those of which we follow the course.

It is an interesting thing that this nesting tendency can be developed in such a non-suggestive bird as our common pigeon, in which one would have expected the presence.

Those who keep Carrier Pigeons know very well that the divided birds very greatly in their ability to find their way, and that a bird must not only develop this ability but must also in some degree know the country over which it is flown in order to obtain best results. In some experiments conducted by Hodge (a bird) a number of years ago, he was surprised to learn something definite concerning this so-called homing instinct. The test was given birds from Massachusetts to Indiana, Wisconsin, and placed them in a pigeon-hole the only view from which was directly against the wall of an adjacent building. After six minutes these birds were released from their hole for the first time, one by one, and their action watched. In each case the pigeon returned first to a nearby roof and sat for a number of minutes looking this way and that. The first bird, for example, sat fifteen minutes on one side of a chimney, then tilted to the other side of the chimney and stood there two minutes gazing carefully about. In three days no number house further off than to a still more distant one, sat there carefully scanning its surroundings as before. Finally it flew off one of sides behind a hill and when half an hour returned to its hole. Each of the pigeons tested for the first time behaved in practically the same way, as if they were gaining a knowledge of their original surroundings and then a look at the neighboring country. All these were young birds not previously released. One of the old birds acted quite differently when released in Indiana. After circling a few times, it flew straight away and was not seen for three days, when falling on clouds in that part of the familiar Wisconsin country, it returned to the hole. After Hodge's

physiologist have given a few drops of bromine to birds that they might learn the exact location of their homes, the birds picked out an random and started in an open wire cage to the top of a hill about half a mile distant, while at the same time the others, also taken at random, were carried to the same spot in a cage closely wrapped in a black cloth. At the first the pigeons, the lot being released started the home at once, one, however, after a few preliminary side swings while the last, resembling the wrong direction, finally turned and alighted at the true home in the home direction. The comparison with the six birds housed from the covered cage is most interesting. The 3 might now make a direct circle for home. Two began circling in the wrong direction, one of them going for water and another went the entire way to the house. The others, after circling or swinging back and forth a few times, finally saw familiar ground and headed for home. There seemed to be, then, no instinctive sense of direction. The birds in the open cage were able to see how they were going and so to keep in mind the general direction of their homewards' trail, when released, really started in the right way, while those in the covered cage had to assume from the birds in continuity of their position and make a general survey of their surroundings until some familiar point was found to give them their location.

Wason and Latimer (1921) have gathered some interesting notes on long-distance flight in Herring Gulls. American hunters have long been trained and used these pigeons, and some very remarkable flights have been made, even at one thousand miles and over. The method is to train the more capable birds to first cover about four hundred miles gradually to increase the distance a hundred miles at a

flies, up to one thousand miles. The story of Wilson's bird that once held the world's record for this distance, is a most interesting one. The study is worthy of higher classification given an distance gradually increasing up to 400, and 500 miles (Little Hawk, Arkansas, to Milwaukee). The fourth year (1920) the bird was taken, after preliminary distances, at Houston, Texas, a thousand miles away in an air line, and there Howard's wife caught her return. All the birds took the homeward course of 400, and Miller was the first to arrive at Milwaukee, after an absence of 4 days, 10 hours, 15 minutes. This performance has since been beaten many times. A world champion, Butler Garry, hatched at Adams, Texas, reached his loft in Plain Elgin, Indiana, a mile long distance of 1000 miles in 1 day, 11 hours, 4 minutes, which is nearest to Wilson's record, may indicate a continuous flight. Other birds in similar flights made this distance in a few longer weeks. But this usually able faculty is not shared by all the birds. The lot of 100 Blushing Pigeons trained on flights of 100 to 100 miles in the direction from Baltimore to Key West, and one over returned when they were released at Key West. The success of the homing birds may vary, some reaching directly the home, others circling first. A speed of fifty miles an hour is a good average on the mid-distance flights.

In the South Sea Islands, Frigate Birds are used after the manner of Blushing Pigeons to carry messages between islands.

Further studies were made by Wilson and Lindsay on Hawks and many Terns in the nesting colonies of the Tanager, off the Florida coast. These birds arrive there in late April or found and leave again in September. With

these species is secured, they would be less chance of their becoming scarce & extinct by the aid of landmarks, for the small lake where they nested is surrounded by rocks. In these different years marked honey and Noddy Terns were marked varying distances and released. They seemed to have little difficulty in returning and were usually back in a few hours even when carried to New Plymouth (4 miles away). During last year, three Noddies and two terns were taken in western to the shores of New York, and released off Cape Hatteras, approximately 400 miles in a direct line. Nearly six days later both terns were back at their original home, and several days later one of the Noddy Terns, plainly marked with dots of oil paint, was also seen back at the nesting colony, but her mate had meanwhile become "phillicious" so that it was not possible to flight into the nest.

One of each species taken in New York Harbor and these returned were never heard of since, though this may be due in part due to the poor conditions in which they nested that place. Brown boobies marked birds placed in several eggs, and released in the Gulf of Mexico, came also within view of their nesting colony. Of the same birds I have written, three Noddies I still with one exception marked birds not as being lost, while the seventh, after a short flight away, came about suddenly and disappeared with the others, all flying within less than a few miles. Through the Noddies returned, made in three days, but none of the four terns was ever seen again. This is the first unqualified flight of a nesting bird, over open water with no landmark visible.

In a second attempt, clusters of each species were taken by long net-lines, taken, and released as follows:

1. Males entered at 11:30 after hour 100; none entered.
 2. Males entered at 12:00 after hour 100; 1 male.
 3. Males entered.
 4. Males entered at 12:30 after hour 100; 1 male.
 5. Males entered.

At the last three (12:30-1:00), the two females returned to 11 and 12. Thus, the Males in hour 100. There might not be more remarkable, but the birds needed (12:30-1:00) did not by themselves, and when they were at least as doing.

The conclusion seems reasonable that there are species, and that there may even be a very small number of species. However, here this is accomplished in not one day, but the various suggested explanations seem to be the solution. The explanation (12:30-1:00), however, that a distinction may be drawn between what they call "passive observation," that is, where the bird goes in looking through recognition of familiar surroundings near home (as in the case of Hedges's pigeons), and "active observation," where the bird takes the right course when far from any such point of view. It is in the latter kind of which birds making long-distance migration seem to proceed, and the explanation of which we will seek. The most useful, however, that these birds have probably been migrating for an immensely long period, and a route as long as that now taken, for example, by the Golden Plover, may have only gradually become of such length. The learning of the route may have been an arduous process, or there may be other explanations. At all events, the case of the Hedges's pigeons seems to indicate an ability to keep constantly on a fixed side regard to a given spot, so that on any of our return, the bird does not lose its bearings. However, here

this is accomplished according to the explanation. The present operation is functioning but would mean there are no loads on which to build it is rather typical. Nevertheless the experimental study by means of standard blocks may considerably be required to confirm the operation eventually. After all, it is a blessing to know that there still is a mystery to unravel us.

CHAPTER III

MANUFACTURING AND CLASSIFICATION

To most persons not professional naturalists, the only just of scientific nomenclature is one of easy memory, and classification is even further remote from their human world. But this need not be so. Nomenclature is merely the naming of things in a logical way so that in talking of them we may have some word or words that will indicate the same thing universally, as well as be familiar to us as referred humans. Nomenclature, or the naming of things, began our study with early man as soon as he learned to communicate with his fellows. The first words were probably quite simple. Among the little African natives, we see the early stages of nomenclature. Large or really distinct grained beads, but sometimes two given single names, but most of the smaller ones are just "little things." So in Macgillivray's account of the Tas Tasmanian Gories and their march through Lake Illawarra, my small bird was called *amashah*, an sparrow, while the Chirids which they saw the darkest blue was named *magpelle amashah*, or the big sparrow. Nomenclature implies then (1) a distinction between objects as well as (2) a grouping of similar ones under the same name. More easily learned to distinguish birds into groups with certain common characteristics, as white, black, yellow, green, sparrows. Each word indicates the kind, as in Latin the genus or genus. The last is most often or that is distinctive is generic term. But when more intimate

knowledge led to classifying more than one kind of skin, some descriptive word had to be added. So in the earlier natural histories we find this done. Latin was the universal language of scholars long after the Western Empire fell and is to some degree so this day. The earlier books on natural history in the state and city-museums were mostly all in this language, and even in the early part of the eighteenth century Latin was the language of books on domestication. As knowledge grew, and more careful distinctions were made, the number of words to name animals of a single "kind" or "genus" was multiplied as he says, so that with the greater name additional descriptive words had to be used. Thus in Linnaeus's *Classification*, even in the eighteenth century, the Indian Kite was spoken of as *Falco tigris* and the Indian Cat Indian *Felis* with one string, though the European kind he used a single term, as *Felis tigris* that the Eastern Eagle, or *Falco tigris* but the white-tailed species. Obviously to use one name descriptive phrases were then not added to speak of a particular sort of bird, its immaturity, nor would everyone use the same combination, so that carelessness in naming of different animals came to use as done and distinctive phrases as possible. However in particular are the Indians.

In 1691 was born Carolus Linnaeus, as his name is Latinized, a Swedish naturalist, who conceived the idea of preparing a list of descriptive catalogues of all the known plants and animals of the world. The first edition of this great work appeared in 1735 and before the century was out had reached no less than thirteen editions, the last of which was edited by this great man's pupil, Goethe. As this work progressed Linnaeus apparently felt that there must be some common way of naming the thousands of differ-

our plates and animals so that they might be referred, by immediately, rather than described, by a phrase. The system was therefore to use a Latin name for each large group or genus of related beings, and a second word, either a descriptive adjective or an appropriate noun, for description. Unlike his predecessors, therefore, he used no set number only only one name to signify each distinct sort of plant or animal that the land, or garden name, or deer for a deer, followed by the sort or specific name, or wood (oak), sheep (sheep name) (sheep) but the Parrot (parrot-like sheep-like deer), or a name as species (oak), the the Wood Oak or White Oak. This use of two names is called therefore binomial nomenclature, that is implies two names, the first of which designates similarity, and is called the genus or generic name; while the second denotes diversity and is called the species or specific name.

Collingridge is now in agreement that the sole edition of Linnaeus's great work, the *Systema Naturæ*, published in 1760, is taken as the starting-point for the nomenclature of vertebrate animals. Since Linnaeus's day, and indeed during his lifetime, the discovery and naming of animals and plants progressed apace, nor have we quite yet reached the complete inventory of the kinds of either. It is frequently held that the same species was named and described more than once, either because two persons thought to be working unknown to each other, or the same subject, on different years, plumages, or parts of one and the same thing were thought to represent distinct species, or in other ways it came about that more than one Latin name was given the same animal. In such cases one is later name has to be held up the first name published, and this because the pre-eminence of the species, all therefore agree

species, whose Indian title the species name proves to have already been used in the same genus, when it is called out, for the name is thereby "parenthesized" and the bird is withdrawn to the appropriate genus where it belongs. As if there was no rule, a new name must be coined. It may be imagined that with the many writers and many species to be named, it often happens that a name already in use is given to some other named species. But the rule is partly to beget it out: that no two species can have the same combination of names. It is due to sheer ignorance, not done the various published names and to identify them carefully that some of many birds, for example, have been changed during the last half-century of name giving. Much as we may regret the inconvenience of such changes in our own day, the ideal of a fixed stable code for the future is the goal of present efforts. We are unfortunately still passing through the period of confusion of names.

The name of the original describer of a species follows the Latin name, and its use is changed is subsequently made by transferring the species described to some other genus; the author's name is enclosed in parentheses. This is when a pencil or printer and others who make the revision of the parentheses for a clerical error, and add one where none should be. For while the species name must properly always remain unchanged, the name of the genus may be, if some later investigation leads the species has been erroneously placed, or if at first it had been placed in a wrong group studies were thought of as belonging to a single genus. Thus we now call the Wood Duck *Colaptes auratus* (Linnaeus). *Colaptes* when first named was being able to tell already from a description what what species it meant. Names were formerly based on many

often upon published pictures of birds, but the last stage is to designate a particular specimen as the one described and this constitutes the type specimen, in which reference is made in case of future doubts. Type specimens should be most carefully preserved, particularly in some large museum of general availability.

Next, very briefly, are the general methods of naming species. The difficulties and most unexpected complications sometimes arise, as in detailed cases with difficulty. The name must reflect all single species has shown, too, that in some cases further refinement in distinction can be made. In a wide-ranging bird, for instance the Phalarope, that moves from the arctic regions to the borders of certain mountains in southern North America, the different climatic conditions in various parts of its range produce a gradual change, so that southern birds may be larger and brighter-colored, the shore-living ones male and small, while others of other areas are still different, yet all are Phalaropes. Hence these differences correspond with certain geographical areas, each with its particular climatic conditions, a sub-species is recognized and called same, as *trichoides*, *lugens* etc. Often it is difficult to tell where one subspecies leaves off and another begins, so gradual may be the change from one to the other process. Sometimes, too, the change is sharp change so that there is doubt whether or not one should call North American species or whether there may be considered each is subspecies of a single kind of bird. An expression, but is that if all the specimens can be selected without doubt as one or the other one, they are species, as in the case of our Cherry and Hairy Woodpeckers, which agree constantly in most characters except size and in certain dark marks on the tail. This subspecies, however,

there are, at least as the function of adjusting organs, to distinguish them and intermediate is not very far removed) so that the extremes are completely bridged. This is called *intergradation*.

Classification, or this system of giving names, differs when a name whereby we may express the relationships of families belongs to arranging them in groups according to their kind. Thus the various geographic subgroups constitute a single species. By grouping together closely related species we have a genus, and several nearly similar genera may constitute a family; or a family may include a single genus if no more relations are known.

In making the family name is made by adding the ending *-idae* to the stem of the name of the original or type genus. The larger divisions of kinds are orders, and they include one or more families, not only a single species in one order, depending partly on the importance of the differences and in part on our estimate of their importance. Such a classification is first of all for convenience, but its chief use is increased by making it express our knowledge of relationships. Here this knowledge is imperfect, so is our arrangement of groups liable to error and gradual correction.

The sufficient classification of animals had enough made in the sixth book of Aristotle's *History of Animals*. I begin in this a new chapter of Revision, the historic line species being only those which were "ancient" or not so far as we know those which were suitable for food. "And there are those which, as shall have in classification among the kinds; they shall not be eaten, they are in domestication: the eagle, the swallow, and the sparrow. And the vole, and the hare after the kind, were eaten after his kind until the end, and the

trace their ancestry back to a common stock in the more or less remote past. The living species of today are represented in a cross-section of the segment ridge. Many groups are usually made from adjacent ridge but often there are long intervals where living species are not adequately related to their near contemporaries. There are often isolated primitive species, such as the New Zealand *Apteryx*, that have survived here and there like living fossils, with no near relatives now known.

There have been many attempts to arrange birds in an orderly sequence, beginning with the most primitive and passing on to the most specialized. There has been much research, much diversity of opinion, but at the present day a general agreement has been nearly reached and is embodied in within the nature police. The system proposed by Huxley in 1881 is the basis of the most modern classification of birds, and this has been completed by Sclater, Sharpe, Huxford, and others. It will suffice to give the outline of this, without attempting to summarize the distinctive traits of the different divisions.

The known species of birds are divided into two great groups: (1) Archaeopteres or ancient birds, and (2) Neopteres or later birds. The first group includes only the *Archaeopteryx* or feathered bird, the *Archaeopteron* fossil from the Jurassic strata of Germany. The second group includes the rest of the known birds. They are placed in numerous chief groups or orders, and the name of each order is given the uniform ending "*-formes*," just as each of the families has the ending "*-idae*" plus the name of the type genus.

Beginning with the fossil feathered birds, *Archaeopteres* and *Apteryges*, each of which is placed in a separate order,

there were now the true Condalia, the Hicoria or South American varieties, the caryocarp, the various Ficus, the land mussel, the various plant-birds of Madagascar, and the birds of America of New Zealand, each of which is now referred to have the rank of a separate order. All these are in many important points of structure peculiarly birds, differing from more ancient ones. They were formerly placed in a separate group called the Psittac birds on account of looking a good way the parrots, but it is now the belief that this distinction is of less importance, but the last was independently added as a support for making it the species of wing flight. The parrot-like structure of South America can be more placed near these birds like birds. They show likeness to the Condalia birds in some of the points, but otherwise have feelings toward the birds. No doubt there exists certain primitive characters very common to many birds.

The penguin form is a special order (Phalacrocoracidae) and are among the most primitive of living birds in many ways. Their structure are almost similar to the albatross, which are highly modified for swimming. The bones of their skulls are less solidly fused than with many birds. They have no special thicker bones, but are uniformly covered, and their nasal bones are heavily fused into a common bone, the bases of the lower original bones still appear.

The bones and girdles form a single order (Colaptes-formae) though the two orders, one with solid, the other with hollow bones, sometimes each is separately divided or laterally. The girdles and effectives form a group (Pterodactyliformes) are usually related to any of the others; all are birds of the spot are and have parallel tubular muscles.

There comes the large assemblage of wood-like birds, which includes a curious company, some very unlike the others. Thus the cormorants and gannets, boobies, terns, albatrosses, frigate, and fringillids are grouped in this order. (Columbiformes, etc., however, constituting a distinct family.

Of this group the most characteristic is hooked beak which in *Halimastur* is entirely lacking. But the other members have a straight and tapering but fish-catching, is most probably acquired structure as a later adaptation. There are rufous-birds, and the division comprising tropicbirds, pelicans, cormorants, shearwaters, gannets, and fringillids is peculiar in having all these now included in the web. The booby and albatross have adapted to sea and land habits to such a degree that the web has disappeared and the legs and toes are lengthened, but the fringillid contains the well-known *Phaethon* that has lost the elongating. The dark-like birds are perhaps not directly related but with the beak *Amorimia* a monophyletic, which are a sort of land birds, perhaps of a primitive ancestral kind, they constitute a separate order (*Amorimiformes*). The vultures, falcons, eagles, hawks, and hawks are probably more nearly akin to cormorants and boobies than we are apt to think, though placed in a group by themselves (*Haliasturiformes*). Their hooked beaks and strong feet recall those of the cormorants. The order *Coliiformes* is a very distinct and rather primitive group by sharing the pinnaceous and tooth. A remarkable feature of most of the groups of this order, the *Columbiformes*, wood-like birds of tropical America, is that they hold a nest in a tree and lay two eggs only. The curious *Phaethon*, with downy in the wing-feathers of the young, is included here as an aberrant form. All the living birds are land birds, but some have drifted off to sea between the seas.

Figure 1. A series of four photographs showing the progression of the fire from the initial ignition to the final stage of the fire.



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The anasidæ birds (Geese) are poorly represented in North America, but include a few cranes and rails. One, the Whooping Crane, is now nearly extinct, though formerly common. The interesting but small point of difference between herons and cranes is that, although both are long-legged and long-necked, the herons, in flying, hold the long neck in an S-bend; while the head down birds (the shorebirds) hold the crown and neck held in stretched out in front. In the structure of palate, (bill-jointment) and nostrils (bill-like) they differ considerably from herons. The young are pinnate.

A most interesting group of water birds is the scoters, by the phalarope species (Chauvinism). They live, even very well what Osborn has called 'adaptive rails' that is, various members of the group have taken up differing ways of life and become somewhat changed in consequence. (Biology followed the two phalaropes (e. g., the Golden Plover) were the most generalized of the group. They are closely related to the sandpipers and plover in bill structure, and in gulls and terns in position, the two groups being those adapted for marsh and shore life, the other to a different life along water or lakes, while a third branch includes the rails, gallinules and plovers, with their peculiar upright posture and diving habits. In another direction with the phalaropes seems to lead to the penguins, which may therefore be thought of as water birds that have taken up land habits. Traits of this former water are seen perhaps in some of their traits, such as the swimming while which they make into water in bodies, sometimes even alighting on the surface of deep water. They also delight in the so-called ice-pine groups (e.g., feeding, but no gulls etc. There is a distinct group of the 'ice' birds, called

analogous, which in many ways indicate the transition from ground to flight. They have somewhat the habit of quail that are active by night.

There is an interesting point about the birds of all these orders of Passeriformes as far as movement, which is that they are walkers or runners, moving the legs dorsally, and holding them out behind as they fly. Through some of them, I note analogous, birds, and beyond some points truly in form, there are considerable typically ground birds and in this respect differ widely from the Passeriformes, as great extent of perching birds which typically use wing-supports that jump from perch to perch, entering it with both feet, and in flight holding the feet forward against the breast. The fact of these birds have four wings, that the grasping reflexes in many of the walking types of birds the hind are broadened to be as in some cases nearly functionless, as if the elongation disappeared. It follows this difference is a very distinct one. The other known bird, *Archaeopteryx*, has a typical perching foot, and it may be the slightest doubt that there existed at the same time other birds with a walking type of foot. The two types are definitely as back as known distance is done. Where primitive birds have taken again to ground habits, they have learned to walk or run, but this is probably a secondary adaptation. The birds are walkers, some of the species can walk, while others both hop or run, or the birds that run or run faster than others, but hops of them is given. This order, Passeriformes, includes most of the quivvers, wrens, warblers, and thrush-like birds, and includes even a third of the living species, approximately seven thousand in number. It is divided for convenience into about 45 families, but the general agreement is important

structure is relatively close. As Griseb says, the chief structural difference between a *Chalcid* and a *Crem* is in size. This group of birds is usually considered the most unspecialized. They are chiefly of small or medium size, and the primaries are reduced or often run on close, while their structure has a more complex muscle system than almost other orders of birds. They include therefore the best singing birds, though in many the song is relatively simple as, in the *Crem*, hardly developed. Not even the *Crem* has more different combinations of his characteristic song.

There are two other large and varied groups of land birds, which are in many respects more primitive though perhaps not directly related to the quail-like birds, namely the cuckoo-like birds (*Cuculiformes*) and the roller-like birds (*Columbiformes*). The cuckoo-like birds are related from their form to land, tree birds, and with them they are included the penguins, which probably were separated long ago, but as living birds are known. Their structure is closest land to birdness especially in France. The rollers are Old World birds, but they are related to the kingfishers, ospreys, herringbirds, woodpeckers, and gnatcatchers. None of us are not in the habit of thinking of birds as related to nightbirds and nightcatchers, but their place is really here rather than near the birds with which they were formerly associated. A superficial point of resemblance is the fact that nearly all these birds lay white eggs, and even owls are, like the nightcatchers, night birds. The beautiful birds kingfishers require not be looking is taken to a hawk, like kingfishers.

While birds of land, the rollers and the roller rollers are quite at home in water, they are not active swimmers. Perhaps birds about in the branches by means of feet and

bill, manipulating birds themselves, jerking up the middle or even legs rather clumsily in the ground, but none of these birds sit down upon or upon rather than walk, leap, or run. Their feet are often small and weak as in wrens and house-sparrows. It would be interesting to know how the feet are held in all these birds while flying. I am certain that in some instances they are stretched backward, and this is the most idea in vogue. The legs are so short in others of these two groups that it is a point difficult to be certain of. Probably the primitive method of holding them out is, bird largely obsolete, however.

By way of convenient summary, the orders of birds are given again below, arranged in general beginning with the least specialized and ending with those that were farthest from the original stock. This is the arrangement adopted by Huxley and Huxley (1902):

From above:

Order	1.....	Archæopteryx
Order	2.....	
Order	3.....	Struthion
Order	4.....	Colymbus
Order	5.....	Struthion, Colymbus, etc.
Order	6.....	Struthion, Colymbus, etc.
Order	7.....	Struthion, Colymbus, etc.
Order	8.....	Struthion, Colymbus, etc.
Order	9.....	Struthion, Colymbus, etc.
Order	10.....	Struthion, Colymbus, etc.
Order	11.....	Struthion, Colymbus, etc.
Order	12.....	Struthion, Colymbus, etc.

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Order 10.— <i>Sphenothecum</i>	grasses (modern names)
Order 11.— <i>Clupathum</i>	hairs and grasses (mostly modern localities)
Order 12.— <i>Pseudanthum</i>	grasses, sedges, ferns, etc.
Order 13.— <i>Clavatum</i>	sedges, ferns, etc.
Order 14.— <i>Clavatum</i>	sedges, ferns, etc.
Order 15.— <i>Clavatum</i>	sedges, ferns, etc.
Order 16.— <i>Clavatum</i>	sedges, ferns, etc.
Order 17.— <i>Clavatum</i>	sedges, ferns, etc.
Order 18.— <i>Clavatum</i>	sedges, ferns, etc.
Order 19.— <i>Clavatum</i>	sedges, ferns, etc.
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Order 99.— <i>Clavatum</i>	sedges, ferns, etc.
Order 100.— <i>Clavatum</i>	sedges, ferns, etc.

In classifying these listed authors of various general authors relating to fossils, it is not to call attention again to the revolutionary viewpoint from which they have been treated. There is much discussion at the present day concerning "evolution" by persons having the most superficial knowledge of what it implies. To many it seems merely that "new names from fossils," an inquiry that seems to

great as he knows; so that certain of our ancient scriptures may have been laid into making upon ourselves against what they call "revolutions," believing that such doctrine is false and opposite. Few know, however, how the slightest knowledge of the real and illuminating doctrines made the skilled and devoted men within the last fifty years. It is now as clearly established as any of our knowledge that throughout the period during which life has existed on this globe, there have been growth and development, progress from stage to stage through the generations of living beings that have gone before. The progress comes with effort, suggestion, with care, and steadily from disease. Therefore, the lesson being the lesson that some would have us believe, is really the most hopeful thing I ever think of in my lifetime.

THE END.

REFERENCES AND NOTES

Abstract

- [illegible]

1. **General Information**
 2. **Administrative**
 3. **Financial**
 4. **Personnel**
 5. **Legal**
 6. **Medical**
 7. **Education**
 8. **Research**
 9. **Public Affairs**
 10. **Other**



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